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PRACTICE WITH SCIENCE.

LONDON
JOHN MURRAY, ALBEMARLE STREET.
1867.

THESE EXPERIMENTS, IT IS TRUE, ARE NOT EASY; STILL THEY ARE IN THE POWER OF EVERY THINKING HUSBANDMAN. HE WHO ACCOMPLISHES BUT ONE, OF HOWEVER LIMITED APPLICATION, AND TAKES CARE TO REPORT IT FAITHFULLY, ADVANCES THE SCIENCE, AND, CONSEQUENTLY, THE PRACTICE OF AGRICULTURE, AND ACQUIRES THEREBY A RIGHT TO THE GRATITUDE OF HIS FELLOWS, AND OF THOSE WHO COME AFTER. TO MAKE MANY SUCH IS BEYOND THE POWER OF MOST INDIVIDUALS, AND CANNOT BE EXPECTED. THE FIRST CARE OF ALL SOCIETIES FORMED FOR THE IMPROVEMENT OF OUR SCIENCE SHOULD BE TO PREPARE THE FORMS OF SUCH EXPERIMENTS, AND TO DISTRIBUTE THE EXECUTION OF THESE AMONG THEIR MEMBERS.

VON THAER, *Principles of Agriculture.*

LONDON: PRINTED BY WILLIAM CLOWES AND SONS, DUKE STREET, STAMFORD STREET, AND CHARING CROSS.

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APPENDIX.

DIRECTIONS TO THE BINDER.

The Binder is desired to collect together all the Appendix matter, with Roman numeral folios, and place it at the *end* of each volume of the Journal, excepting Titles and Contents, and Statistics, &c., which are in all cases to be placed at the *beginning* of the Volume: the lettering at the back to include a statement of the *year* as well as the *volume*; the first volume belonging to 1839-40, the second to 1841, the third to 1842, the fourth to 1843, and so on.

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VITAL STATISTICS; METEOROLOGY; IMPORTS OF GRAIN; QUANTITIES OF BRITISH WHEAT SOLD; PRICES OF FOOD; EMIGRATION; PAUPERISM; ACREAGE OF CROPS, GRASS, &c.; NUMBERS OF CATTLE AND SHEEP.

[*The facts are selected from the Reports of the* Registrar-General; *the Meteorological Reports of* Mr. Glaisher; *the Returns of the* Inspector-General of Imports and Exports, and of the Board of Trade.]

Population of the United Kingdom estimated to the middle of 1866:—

Males	14,459,314
Females	15,476,090
Persons	29,935,404

Of the total number of persons England contained, 21,210,020; Scotland, 3,153,413; Ireland, 5,571,971.

The recorded number of Emigrants from British and Irish ports in 1866 was 204,882, or 561 daily. Between the excess of births over deaths in the United Kingdom and the emigration from it, the difference was 390 daily.

England.

	Births in 1866.	Annual Birth-rate to 1000 persons living (1866).	Average Birth-rate to 1000 persons living (1856-65).
First Quarter: Jan., Feb., March ..	196,737	37·76	36·44
Second Quarter: April, May, June ..	192,459	36·44	36·20
Third Quarter: July, Aug., Sept. ..	178,982	33·44	33·43
Fourth Quarter: Oct., Nov., Dec. ..	185,010	34·47	33·22
Year	753,188	35·53	34·82

	Deaths in 1866.	Annual Death-rate to 1000 persons living (1866).	Average Death-rate to 1000 persons living (1856-65).
First Quarter: Jan., Feb., March ..	138,233	26·53	25·04
Second Quarter: April, May, June ..	128,692	24·37	21·86
Third Quarter: July, Aug., Sept. ..	116,826	21·82	20·02
Fourth Quarter: Oct., Nov., Dec. ..	117,187	21·84	22·05
Year	500,938	23·64	22·24

In districts that comprise the chief towns the mortality wa 26·39. In districts comprising small towns and country parishe 20·10.

The eleven divisions may be thus arranged in the order annual mortality: the deaths per 1000 were in the South-Easte counties 19, Eastern counties 20, South-Midland counties 20, Sout Western counties 20, North-Midland counties 21, West-Midla counties 22, Monmouthshire and Wales 23, Northern counties 2 Yorkshire 26, London 26, North-Western counties (Lancashire a Cheshire) 29.

The Black country, as it is called, about Wolverhampton, may cited amongst other proofs of the efficiency of hygienic measure The cholera epidemics of 1849 and 1854 destroyed in five distric more than 3000 lives, while in the year 1866 the mortality fro cholera has been inconsiderable. The water was formerly impu and could only be obtained with difficulty in a country cover with pits and works; but good water having been brought from distance, the population is reaping the advantages of the change.

METEOROLOGY.

Third Quarter (*July*, *August*, *September*). The mean temperatu of the air at Greenwich in the summer quarter was 58·9°, whi is 1·1° below the average of the season in twenty-five years. Ea of the three months, but particularly August, was cold. The rai fall measured 7·9 inches, half of which occurred in Septembe when the amount exceeded the average by an inch and a half. T weather, which had been warm and fine at the close of the previo quarter, changed to cold at the beginning of July, and in eve part of the country rain fell almost daily. From the 9th to the 17 was a period of heat, but from the 18th July to the 27th Septemb the temperature was almost constantly low. Rain fell frequent all over the country in July, and in August seriously interrupt harvest work. In September the atmospheric pressure was alwa low, and in Guernsey and the west of England 8 or 9 inches of ra fell; near the east coast 3 inches; about London 4 inches. In t midland counties there were floods; thousands of acres were und water, and much damage was done. In the three visitations cholera in past years there was great atmospheric pressure, hi temperature, narrow diurnal range owing chiefly to high nig temperature, defect of rain, wind, and electricity; and in the la of those (1854) a remarkable blue mist was observed which pr vailed night and day. In nearly all these particulars the meteor

logical character of the present epidemic season is different from that of previous periods when cholera prevailed; but the blue mist has been again visible; it was first seen by Mr. Glaisher on 30th July, and by other observers in the preceding week. Since that time it has been generally present; on some days no trace of it visible, and on other days seen for parts of a day only. It has extended from Aberdeen to the Isle of Wight, and was of the same tint of blue everywhere. This mist increased in intensity when viewed through a telescope; usually no mist can be seen when thus viewed; it increased in density during the fall of rain, though usually mist rises from rain. Its density did not decrease when the wind was blowing moderately strong; it decreased when a gale was blowing, but increased again on its subsidence. Whatever may be its nature, the fact is very remarkable, that since the cholera period of 1854 this phenomenon has not been observed till the present time.

Fourth Quarter (*October, November, December*). The close of the autumnal quarter was distinguished by much rain and the want of sunshine, and by south-west winds which had long prevailed. In the first week of October the barometer rose, the wind changed to north-east, and the mean temperature for eleven days was 3° above the average. This was followed by a week of cold weather. From 19th October to the end of the quarter the temperature was in excess without any considerable interruption, except from 28th November to 2nd December, in which period the weather was cold.

October closed with variable weather, sometimes with fog, at others with rain, and occasional white frosts at night. In the beginning of November barometric pressure exhibited great fluctuations; snow fell in Scotland; and throughout the month the weather was changeable. In December there was frequent rain, and there were very heavy gales from the south-west; but the month was unusually mild for the season. The last two months were favourable for agricultural operations. In November ploughing and sowing made great progress, except in Yorkshire and Lancashire, where about the middle of the month were extensive floods; and at the end of the year the pastures were of a fresh green, and food for cattle was abundant.

At Greenwich in each month the mean temperature was above the average. It was 51·3° in October, 44·3° in November, 42·9° in December; the mean of the quarter was 46·2°. Rain fell to the amount of 5·4° inches in the quarter, which is 1·7 inches below the average.

Meteorological Observations made at the Royal Observatory, Greenwich, in the Last Six Months of 1866.

1866. Months.	Temperature of: Air. Mean.	Air. Diff. from average of 95 years.	Air. Diff. from average of 25 years.	Evaporation. Mean.	Evaporation. Diff. from average of 25 years.	Dew Point. Mean.	Dew Point. Diff. from average of 25 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 25 years.	Water of the Thames.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 25 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour in a Cubic Foot of Air. Diff. from average of 25 years.
	°	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
July	61·0	−0·4	−0·7	57·1	−0·3	53·7	0·0	20·1	−0·8	65·7	·413	·000	4·6	0·0
August ..	59·4	−1·3	−1·8	55·9	−1·4	52·7	−1·1	17·1	−2·6	61·4	·399	−·019	4·5	−0·1
September..	56·4	−0·1	−0·7	53·9	−0·1	51·5	+0·4	14·5	−4·2	58·3	·381	·000	4·3	+0·1
Mean ..	58·9	−0·6	−1·1	55·6	−0·6	52·6	−0·2	17·2	−2·5	61·8	·398	−·006	4·5	0·0
	°	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
October ..	51·3	+1·6	+0·8	49·8	+1·3	48·2	+1·8	12·5	−2·1	55·0	·338	+·022	3·8	+0·1
November..	44·3	+1·9	+0·3	42·2	+0·5	39·7	−0·2	12·5	+0·8	45·3	·244	−·008	2·8	0·0
December ..	42·9	+3·8	+2·5	41·3	+2·4	39·3	+2·2	10·2	+0·7	42·2	·240	+·017	2·8	+0·2
Mean ..	46·2	+2·4	+1·2	44·4	+1·4	42·4	+1·3	11·7	−0·2	47·5	·274	+·010	3·1	+0·1

Note.—In reading this table it will be borne in mind that the sign (−) minus signifies below the average, and that the sign (+) plus signifies above the average.

METEOROLOGICAL OBSERVATIONS MADE AT THE ROYAL OBSERVATORY, GREENWICH, IN THE LAST SIX MONTHS OF 1866.

1866. MONTHS.	Degree of Humidity.		Reading of Barometer.		Weight of a Cubic Foot of Air.		Rain.		Daily Horizontal movement of the Air.	Reading of Thermometer on Grass.				
										Number of Nights it was				
	Mean.	Diff. from average of 25 years.	Mean.	Diff. from average of 25 years.	Mean.	Diff. from average of 25 years.	Amount.	Diff. from average of 51 years.		At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
July	78	+ 2	29·770	−0·033	528	0	1·6	−1·0	233	0	3	28	38·9	58·5
August ..	79	+ 2	29·637	−0·154	528	− 1	2·4	0·0	254	0	0	31	41·1	55·2
September ..	84	+ 3	29·581	−0·247	530	− 4	3·9	+1·5	251	0	3	27	33·1	54·9
							Sum	Sum	Mean	Sum	Sum	Sum	Lowest	Highest
Mean ..	80	+ 2	29·663	−0·145	529	− 2	7·9	+0·5	246	0	6	86	33·1	58·5
			in.	in.	grs.	grs.	in.	in.	Miles				°	°
October ..	90	+ 3	29·933	+0·247	542	+ 4	2·1	−0·7	186	3	11	17	24·8	54·3
November ..	84	− 5	29·792	+0·044	548	+ 1	1·5	−0·9	333	12	14	4	21·1	46·9
December ..	87	− 1.	29·790	−0·042	549	− 3	1·8	−0·1	340	11	16	4	21·0	49·7
							Sum	Sum	Mean	Sum	Sum	Sum	Lowest	Highest
Mean ..	87	− 1	29·838	+0·063	546	+ 1	5·4	−1·7	286	26	41	25	21·0	54·3

NOTE.—In reading this table it will be borne in mind that the sign (−) minus signifies below the average, and that the sign (+) plus signifies above the average.

The AVERAGE PRICES of Consols, of Wheat, of Meat, and of Potatoes; also AVERAGE NUMBER of PAUPERS relieved on the *last day* of each Week; an[d] MEAN TEMPERATURE; in each of the Nine Quarters ending December 31st, 18[6]

Quarters ending	AVERAGE PRICES.					PAUPERISM.		M T rat G
	Consols (for Money).	Wheat per Quarter in England and Wales.	Meat per lb. at Leadenhall and Newgate Markets (by the Carcase).		Best Potatoes per Ton at Waterside Market, Southwark.	Quarterly Average of the Number of Paupers relieved on the *last day* of each week.		
			Beef.	Mutton.		In-door.	Out-door.	
1864	£.	*s.* *d.*						
Dec. 31	89⅝	38 5	4½*d.*—7*d.* Mean 5¾*d.*	5¼*d.*—7¼*d.* Mean 6¼*d.*	80*s.*—95*s.* Mean 87*s.* 6*d.*	128,322	771,879	4
1865								
Mar. 31	89⅜	38 4	4½*d.*—7*d.* Mean 5¾*d.*	5½*d.*—7¼*d.* Mean 6¼*d.*	85*s.*—97*s.* Mean 91*s.*	142,329	813,371	3
June 30	90⅝	40 6	4¾*d.*—6¾*d.* Mean 5¾*d.*	6¼*d.*—8½*d.* Mean 7⅜*d.*	90*s.*—115*s.* Mean 102*s.* 6*d.*	125,846	776,016	5
Sept. 30	89⅝	43 3	4½*d.*—7*d.* Mean 5¾*d.*	6¼*d.*—8¾*d.* Mean 7½*d.*	65*s.*—100*s.* Mean 85*s.*	117,172	719,589	6
Dec. 31	88⅛	44 10	4¼*d.*—7*d.* Mean 5⅝*d.*	5⅛*d.*—8¼*d.* Mean 6⅞*d.*	60*s.*—90*s.* Mean 75*s.*	129,036	725,259	4
1866								
Mar. 31	87	45 6	4½*d.*—6¾*d.* Mean 5⅝*d.*	5½*d.*—7¾*d.* Mean 6⅝*d.*	55*s.*—90*s.* Mean 72*s.* 6*d.*	139,546	759,402	4
June 30	86⅛	46 6	4¾*d.*—7*d.* Mean 5⅞*d.*	5½*d.*—8½*d.* Mean 7*d.*	60*s.*—95*s.* Mean 77*s.* 6*d.*	123,657	734,139	5
Sept. 30	88⅜	51 0	5¼*d.*—7¼*d.* Mean 6⅛*d.*	5½*d.*—8¼*d.* Mean 6⅜*d.*	75*s.*—120*s.* Mean 97*s.* 6*d.*	120,955	717,553	5
Dec. 31	89⅛	56 8	4¾*d.*—7*d.* Mean 5⅞*d.*	5¼*d.*—7½*d.* Mean 6⅜*d.*	85*s.*—130*s.* Mean 107*s.* 6*d.*	133,979	734,312	4

Of the 204,882 emigrants who left the country in 1866, 58,856 were of English origin; 12,307 were Scotch; 98,890 were Irish, 26,691 foreigners, 8138 of country not distinguished. About a fourth part of the total emigration consisted of "general labourers." The number specially described as "agricultural labourers" was less than 2000.

Messrs. Horne and Co. of London write as follows:—

"With the exception of the last fortnight in June, the weather in 1866 was, upon the whole, unseasonably wet and mild, just when it would have been desirable to be dry and cold, and *vice versâ*. A snowless winter, a chilly spring, a sunless summer, and a weeping autumn. The grain crops were, in many instances, cut before they were ripe, or carried from the fields too quickly, while in the North of England and in Scotland the harvests were protracted to an unusually late period, in some cases even in November; but fortu-

mately the coldness of the autumn prevented sprouting in the different kinds of grain, and the damage done proves to be less than was reasonably expected. The continental wars somewhat influenced prices, but unusual and manifold were the causes of the rapid rise, viz., the bad harvests in this and neighbouring countries, the enormous diminution of stocks in granary and in the hands of farmers, the very low price of the last three years, and the inability of America to supply the deficiencies of England and France, while the last-named country has not only competed with us to a large extent in the South Russian and Baltic markets, but has drawn off some cargoes of our best qualities of home growth. In the early part of 1866, wheat was *exported* from this country to America and to Australia. The *total importation* of all kinds of grain and flour into the United Kingdom in 1866 was 63,259,922 cwts., against 49,237,598 cwts. in 1865. The *total estimated value* is probably about 29,100,000*l.* against 20,643,000*l.* in 1865."

GRAIN and FLOUR from different countries imported into the United Kingdom in 1865 and 1866.

	1865.		1866.
	Cwts.		Cwts.
Wheat from Russia	8,093,879	..	8,937,199
,, Denmark	641,273	..	4,401,409
,, Prussia	5,403,914	..	506,236
,, Schleswig, Holstein, and Lauenberg	254,159	..	187,938
,, Mecklenburg	647,685	..	733,571
,, Hanse Towns	486,069	..	878,912
,, France	2,252,873	..	3,473,130
,, Turkey and Wallachia and Moldavia	574,185	..	528,433
,, Egypt	10,063	..	33,831
,, United States	1,177,618	..	635,239
,, British North America	306,765	..	8,789
,, Other countries	1,114,480	..	2,831,642
Total	20,962,963	..	23,156,329
Barley	7,818,404	..	8,433,863
Oats	7,714,230	..	8,844,586
Peas	783,135	..	1,211,835
Beans	958,362	..	1,324,173
Indian Corn, or Maize	7,096,033	..	14,322,863
Wheatmeal and Flour from Hanse Towns	247,796	..	347,012
,, ,, France	3,044,823	..	3,640,320
,, ,, United States	256,769	..	280,792
,, ,, British North America	177,353	..	40,650
,, ,, Other countries	177,730	..	663,506
Total	3,904,471	..	4,972,280

QUANTITIES of WHEAT, BARLEY, and OATS, IMPORTED into the UNITED KINGDOM in each of the last SIX MONTHS of the YEAR 1866.

1866.	Wheat.	Barley.	Oats.
THIRD QUARTER.	cwts.	cwts.	cwts.
Seventh month (four weeks ending July 28)	2,102,486	370,616	935,616
Eighth month (four weeks ending August 25	1,600,337	353,978	1,489,129
Ninth month (five weeks ending September 29)	1,452,152	547,076	880,349
FOURTH QUARTER.			
Tenth month (four weeks ending October 27)	1,438,142	715,981	522,932
Eleventh month (four weeks ending November 24)	1,716,370	889,723	518,084
Twelfth month (five weeks ending December 29)	3,333,603	1,580,348	813,773
Total in the half year	11,643,090	4,457,722	5,159,883

NOTE.—The average weights *per quarter* of corn, as adopted in the office of the Inspector-General of Imports and Exports, are as follows:—For wheat, 485⅓ lbs., or 4⅓ cwts.; for barley, 400 lbs., or 3 4/7 cwts.; for oats, 308 lbs., or 2¾ cwts. Corn has been entered and charged with duty by *weight* instead of *measure* since September 1864.

QUANTITIES of BRITISH WHEAT SOLD in the Towns from which Returns are received under the Act of the 27th and 28th VICTORIA, cap. 87; and their AVERAGE PRICES; in each of the last SIX MONTHS of the Years 1861-66.

	WHEAT: QUANTITIES IN QUARTERS.					
	1861.	1862.	1863.	1864.	1865.	1866.
	quarters.	quarters.	quarters.	quarters.	quarters.	quarters.
Seventh month	159,152	163,720	162,817	257,510	222,961	127,836
Eighth month	208,400	138,810	187,011	264,939	201,953	191,057
Ninth month (five weeks)	455,324	264,410	390,308	322,292	318,893	325,056
Tenth month ..	427,435	273,000	333,609	311,169	304,054	320,674
Eleventh month	345,028	265,160	325,209	302,446	295,652	284,530
Twelfth month (five weeks)	359,246	315,599	472,876	399,358	391,941	332,934

	WHEAT: AVERAGE PRICES PER QUARTER.											
	1861.		1862.		1863.		1864.		1865.		1866.	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
Seventh month	50	8	57	0	46	7	42	0	42	10	54	1
Eighth month ..	50	8	57	8	46	2	43	7	43	3	50	7
Ninth month (five weeks)	54	7	56	1	44	6	42	0	44	0	49	0
Tenth month ..	56	10	49	5	40	10	38	9	41	10	52	4
Eleventh month	59	10	49	0	39	11	38	10	45	7	56	6
Twelfth month (five weeks)	60	10	46	8	40	9	38	3	46	8	60	3

AVERAGE PRICES of BRITISH WHEAT, BARLEY, and OATS per Quarter (imperial measure) as received from the INSPECTORS and OFFICERS of EXCISE according to the Act of 27th and 28th VICTORIA, cap. 87, in each of the last TWENTY-SIX WEEKS of the Year 1866.

Week ending	Wheat. s.	d.	Barley. s.	d.	Oats. s.	d.	Week ending	Wheat. s.	d.	Barley. s.	d.	Oats. s.	d.
July 7	54	6	35	5	27	7	October 6 ..	52	2	41	4	23	1
July 14 ..	55	10	35	1	27	7	October 13	52	7	42	1	23	0
July 21 ..	54	0	33	5	26	2	October 20	52	2	42	11	22	11
July 28 ..	52	0	33	10	27	1	October 27	52	6	41	8	22	10
August 4 ..	51	1	32	11	25	3	November 3	54	9	43	10	23	7
August 11 ..	50	2	35	2	26	6	November 10	57	2	44	9	23	5
August 18 ..	50	2	34	9	26	6	November 17	56	7	45	3	23	6
August 25 ..	50	10	33	8	26	6	November 24	57	6	45	6	23	9
September 1	49	7	35	1	25	3	December 1	60	0	45	10	25	5
September 8	47	3	36	1	25	2	December 8	61	7	46	2	24	3
September 15	47	0	37	1	24	8	December 15	60	3	45	7	24	5
September 22	49	8	37	10	24	1	December 22	59	5	44	4	25	11
September 29	51	5	40	1	24	3	December 29	60	0	44	0	24	3

AVERAGE PRICES per Quarter of British Corn in ENGLAND and WALES in each of the Years 1863, 1864, 1865, and 1866.

	1863. s.	d.	1864. s.	d.	1865. s.	d.	1866. s.	d.
Wheat	44	9	40	2	41	10	50	0
Barley	33	11	30	0	29	9	37	6
Oats	21	3	20	1	21	10	24	8

STATUTE ACRES under CROPS, GRASS, &c.; NUMBERS of CATTLE and SHEEP.

	Population in 1861.	Area in Statute Acres.	Acreage under all kinds of Crops, Bare Fallow, and Grass (1866).	Estimated Ordinary Stock of Cattle (1866).	Number of Sheep as returned in 1866.
England ..	18,954,444	32,590,397	22,261,833	3,420,044	15,124,541
Wales ..	1,111,780	4,734,486	2,284,674	546,966	1,668,663
Scotland ..	3,062,294	19,639,377	4,158,360	968,637	5,255,077
Ireland ..	5,798,967	20,322,641	15,549,796*	3,742,932	4,270,027

* Hill pastures are *excluded* in Great Britain, *included* in Ireland.

	Wheat. Acres.	Barley or Bere. Acres.	Oats. Acres.	Rye. Acres.	Beans. Acres.	Peas. Acres.	Total of Corn Crops. Acres.
England	3,161,431	1,877,387	1,503,990	50,570	492,586	314,206	7,400,170
Wales ..	113,862	146,323	251,893	2,452	3,534	3,010	521,074
Scotland	110,101	213,619	1,004,040	7,055	28,537	3,188	1,366,540
Ireland ..	300,474	152,777	1,697,648	7,753	12,175	2,606	2,173,433

In England wheat formed 42·7 per cent. of corn crops; barley 25·4, oats 20·3. In Wales the proportions were respectively 21·8, 28·1, 48·3; in Scotland 8·1, 15·6, 73·5; in Ireland 13·8, 7·0, 78·1.

VITAL STATISTICS:—POPULATION; BIRTHS; DEATHS; EMIGRATION; METEOROLOGY; IMPORTATIONS OF GRAIN; SALES OF BRITISH WHEAT; PRICES OF CORN, &c.; AND PAUPERISM.

[*The facts are derived chiefly from the Reports of the* REGISTRAR-GENERAL; *the Meteorological Reports of* Mr. GLAISHER; *the Returns of the* BOARD OF TRADE, *and the* INSPECTOR-GENERAL OF IMPORTS AND EXPORTS.]

POPULATION of the UNITED KINGDOM, estimated to the middle of the year 1867 (exclusive of islands in the British seas):—

Males	14,548,808
Females	15,608,431
Total	30,157,239

	England.	Scotland.	Ireland.
Males	10,365,688	1,496,329	2,686,791
Females	11,063,820	1,674,440	2,870,171
Total ..	21,429,508	3,170,769	5,556,962

ENGLAND AND WALES.

BIRTHS and DEATHS in the first six months of 1867.

Births in Winter quarter (January, February, March), 195,455. Annual birth-rate to 100 living—Winter, 3·713; average,* 3·663.

Births in Spring quarter (April, May, June), 199,649. Annual birth-rate to 100 living—Spring, 3·742; average,* 3·619.

Deaths in Winter quarter (January, February, March), 134,254. Annual death-rate to 100 living—Winter, 2·551; average,* 2·551.

Deaths in Spring quarter (April, May, June), 112,523. Annual death-rate to 100 living—Spring, 2·109; average,* 2·218.

The mortality per cent. in the districts of England that comprise the CHIEF TOWNS was 2·732 in the winter quarter; while that of SMALL TOWNS and COUNTRY PARISHES was 2·315. In the Spring the rate of mortality declined in the large towns to 2·119, and in the small towns and rural parts to 1·991.

The returns in the Winter quarter were on the whole satisfactory.

* The averages are drawn from the corresponding winters or springs in ten years, 1857-66.

The marriages and the births were above the average numbers. The death-rate was exactly the average of the season, but lower than in any of the three previous winters. Had it not been for the intensely cold weather in January, which proved fatal to many old people, and for epidemics of whooping-cough, small-pox, and measles, the results would have been still more favourable. Cholera was only epidemic in Durham. Prices were high, and potatoes—an esculent which possesses valuable antiscorbutic properties—were scarce.

The Spring quarter was genial. The births exceeded the average number of the season, and the low mortality presented a striking contrast to that prevailing in the spring of 1866. Sanitary work was accelerated last year by the impending epidemic of Asiatic cholera, and the efforts then made appear to have borne fruit. The marriage-rate was below the average in the winter quarter, and reflected the prevailing depression of certain classes of industry.

If care is not taken to ventilate the sewers thoroughly, the volatile matters by which typhoid fever and other zymotic diseases are propagated, must be communicated, by means of the house-drains, from one dwelling to another. But the chief security against a danger incidental to the existing system of town drainage lies in abundance of water, with sufficient fall to propel the whole body of refuse to a distance, and to disperse its gases in limitless space.

Increase of Population, and Emigration.

The excess of births over deaths in the Winter quarter was 61,201; in the Spring quarter 87,126, which latter number represents an excess of 957 daily. Against this increase is put the loss by emigration. The number of emigrants in the former quarter from all ports in the United Kingdom where emigration officers are stationed, was 26,753, of whom about 8000 were English, 1200 Scotch, 14,000 Irish, 3000 foreigners. There went to the United States nearly 7000 English, 900 Scotch, 13,000 Irish. 2000 persons of various origin went to the Australian colonies; less than 100 to British North America.

In the March quarter of the three years 1865-6-7, the total emigration was 27,513, 39,672, and 26,753.

In the Spring quarter 73,571 emigrants, of whom 12,695 were foreigners, left British and Irish shores. Of 16,718 persons of English origin, 11,980 went to the United States, 2028 to British North America, 2142 to the Australian colonies, and 568 to other places.

METEOROLOGY.

First Quarter (January, February, March). The month of January opened with a severe frost, which continued at Greenwich till the 5th, and the defect of temperature was great, particularly on the 4th. The thermometer fell to zero at many places, and below that point at others. Snow fell frequently all over the country, and to such amount that traffic by road or railway was rendered difficult, and in some places was quite suspended. This severity of weather was succeeded by a sudden thaw, and by heavy gales of wind from the west and south-west. The snow was cleared away rapidly, and its sudden melting caused rivers to overflow their banks in many parts of the country. From January 6th to 10th the average excess of daily temperature above the average was 7°. On the 11th another period of frost set in and continued till January 22d, during which there were several very heavy falls of snow, especially in the northern parts of the kingdom. Cases were reported of persons who had perished in the snow. The average daily deficiency of temperature on those twelve days was nearly 10°. On the morning of the 23d a sudden change took place; the temperature was no less than 20° higher than that of the preceding day, and a period of warmth almost unprecedented for the season commenced, which lasted for thirty-five days. The average excess of temperature during this period was 7° daily; and it is necessary to go back as far as 1779 for a period of higher temperature and of equally prolonged duration. The melting of the snow and heavy falls of rain produced inundations which were extensive in some parts of Yorkshire and Lincolnshire. From February 27th to the end of March the weather, except on a few days, was cold and wintry; snow and sleet were frequent all over the country. In the first three weeks of March the average daily defect of temperature at Greenwich was nearly 7°. January and March will be distinguished in meteorology for their severe frosts and snow-falls, February by its high temperature, and the whole quarter by an unusual succession of heavy gales. In February the excess of rain and the floods impeded agricultural operations; while in March vegetation was checked, and growing crops damaged by the protracted wintry character of the season.

Second Quarter (April, May, June). At Greenwich the mean temperature of the air in the shade was 53°·5; it was 1°·3 above the average of 96 years. Of every month the temperature was above the average; but the variations were so unusually great as to seriously affect plants of every kind. April was unsettled, windy,

rainy,

METEOROLOGICAL OBSERVATIONS RECORDED AT THE ROYAL OBSERVATORY, GREENWICH, IN THE FIRST SIX MONTHS OF THE YEAR 1867.

1867. MONTHS.	Temperature of: Air. Mean.	Air. Diff. from average of 96 years.	Air. Diff. from average of 26 years.	Evaporation. Mean.	Evaporation. Diff. from average of 26 years.	Dew Point. Mean.	Dew Point. Diff. from average of 26 years.	Air—Daily Range. Mean.	Air—Daily Range. Diff. from average of 26 years.	Water of the Thames.	Elastic Force of Vapour. Mean.	Elastic Force of Vapour. Diff. from average of 26 years.	Weight of Vapour in a Cubic Foot of Air. Mean.	Weight of Vapour in a Cubic Foot of Air. Diff. from average of 26 years.
	°	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
January ..	34·2	−2·0	−4·1	32·6	−4·4	29·7	−5·4	11·0	+1·3	34·8	0·165	−0·038	2·0	−0·4
February ..	44·7	+6·4	+6·0	42·5	+5·4	40·0	+5·4	11·2	−0·2	44·2	0·247	+0·044	2·8	+0·4
March ..	37·7	−3·3	−4·0	35·5	−3·9	32·5	−3·9	11·5	−3·1	39·6	0·184	−0·033	2·1	−0·4
Mean ..	38·9	+0·4	−0·7	36·9	−1·0	34·1	−1·3	11·2	−0·7	39·5	0·199	−0·009	2·3	−0·1
	°	°	°	°	°	°	°	°	°	°	in.	in.	grs.	gr.
April	49·0	+3·1	+2·2	46·1	+2·3	43·0	+2·6	16·4	−2·1	49·0	0·277	+0·026	3·1	+0·2
May	53·4	+0·8	+0·5	49·4	+0·2	45·4	−0·1	20·0	−0·3	54·6	0·304	+0·002	3·4	0·0
June	58·1	0·0	−1·0	53·8	−0·9	50·0	−0·8	21·1	−0·2	61·3	0·361	−0·012	4·0	−0·2
Mean ..	53·5	+1·3	+0·6	49·8	+0·5	46·1	+0·6	19·2	−0·9	55·0	0·314	+·005	3·5	0·0

NOTE.—It must be understood that the sign *plus* (+) signifies that the value in the preceding column was *above* the average; and that *minus* (−) signifies that it was *below* the average.

METEOROLOGICAL OBSERVATIONS RECORDED AT THE ROYAL OBSERVATORY, GREENWICH, IN THE FIRST SIX MONTHS OF THE YEAR 1867.

1867. MONTHS.	Degree of Humidity.		Reading of Barometer.		Weight of a Cubic Foot of Air.		Rain.		Daily Horizontal movement of the Air.	Reading of Thermometer on Grass.				
										Number of Nights it was				
	Mean.	Diff. from average of 26 years.	Mean.	Diff. from average of 26 years.	Mean.	Diff. from average of 26 years.	Amount.	Diff. from average of 52 years.		At or below 30°.	Between 30° and 40°.	Above 40°.	Lowest Reading at Night.	Highest Reading at Night.
			in.	in.	grs.	grs.	in.	in.	Miles.				°	°
January ..	83	− 5	29·520	−0·235	554	0	2·8	+1·1	346	18	10	3	5·2	44·0
February ..	84	− 1	29·911	+0·123	549	− 4	1·2	−0·3	344	2	19	7	29·1	44·7
March ..	82	0	29·624	−0·123	552	+ 2	2·3	+0·7	329	18	10	3	18·5	44·2
							Sum	Sum	Mean	Sum	Sum	Sum	Lowest	Highest
Mean ..	83	− 2	29·678	−0·078	552	− 1	6·3	+1·5	340	38	39	13	5·2	44·7
			in.	in.	grs.	grs.	in.	in.	Miles				°	°
April	80	+ 1	29·629	−0·139	539	− 4	2·2	+0·5	407	3	14	13	25·1	49·2
May	74	− 2	29·738	−0·037	537	− 5	2·3	+0·2	234	4	9	18	25·7	50·0
June	75	+ 1	29·935	+0·139	535	+ 4	1·8	−0·2	232	1	5	24	30·0	54·2
							Sum	Sum	Mean	Sum	Sum	Sum	Lowest	Highest
Mean ..	76	0	29·767	−0·012	537	− 2	6·3	+0·5	291	8	28	55	25·1	54·2

NOTE.—It must be understood that the sign *plus* (+) signifies that the value in the preceding column was *above* the average; and that *minus* (−) signifies that it was *below* the average.

rainy, and warmer than usual. May, after the first few d brought us brilliant sunshine; the heat of summer filled the and vegetation shot out luxuriantly. Then came a great cha the sky grew cloudy, the weather cold, the nights frosty. ground and the tender shoots of plants were frozen. Flowers in blossom; the cuckoo, the swallow, and the nightingale come; but it was winter weather. The young shoots of holly, walnut, beech, and even oak, were injured in many places. St berries and peas in flower were nipped; potatoes were dama At the end of May and in the beginning of June came warmth rain, followed by cooler days to the end of the month. The crop was excellent, and was stacked in good condition. No sig the potato disease were visible.

FOOD—PRICES.

QUANTITIES of WHEAT, WHEATMEAL and FLOUR, BARLEY, OATS, PEA BEANS, IMPORTED into the UNITED KINGDOM in each of the first MONTHS of the YEAR 1867.

1867.	Wheat.	Wheatmeal and Flour.	Barley.	Oats.	Peas.	B
	cwts.	cwts.	cwts.	cwts.	cwts.	c
January ..	2,280,431	369,735	925,866	709,877	190,440	16
February	1,423,169	266,934	421,591	280,370	73,509	17
March ..	2,358,252	248,514	789,199	639,967	49,053	17
April ..	3,230,018	245,280	589,184	781,584	72,421	13
May	3,212,207	387,971	380,640	1,113,114	162,180	15
June ..	1,944,479	304,638	229,996	756,238	195,515	19
Total in Six Months	14,448,556	1,823,072	3,336,476	4,281,150	743,118	99

NOTE.—The average weights *per quarter* of corn, as adopted in the office Inspector-General of Imports and Exports, are as follows:—For wheat, 48 or 4¼ cwts.; for barley, 400 lbs., or 3½ cwts.; for oats, 308 lbs., or 2¾ cwts. has been entered and charged with duty by *weight* instead of *measure* sinc tember 1864.

QUANTITIES of WHEAT, BARLEY, OATS, PEAS, BEANS, INDIAN CORN or MAIZE, WHEATMEAL and FLOUR, IMPORTED in the SIX MONTHS ended 30th JUNE in the THREE YEARS 1865-6-7; also the COUNTRIES from which the WHEAT and WHEATMEAL were obtained.

	1865.	1866.	1867.
Wheat from—	cwts.	cwts.	cwts.
Russia	2,693,820	3,649,398	5,147,296
Denmark	233,665	148,615	305,412
Prussia	2,260,322	1,663,193	3,532,054
Schleswig, Holstein, and Lauenburg	134,640	73,507	83,599
Mecklenburg	260,768	302,225	498,343
Hanse Towns	245,822	315,701	432,281
France	460,662	2,683,389	418,793
Turkey and Wallachia and Moldavia	352,393	295,973	1,338,159
Egypt	..	7,012	48,505
United States	212,901	315,160	1,071,512
British North America	21,187	8,789	87
Other countries	586,088	2,045,714	1,572,515
Total Wheat	7,462,268	11,508,676	14,448,556
Barley	4,161,894	3,954,929	3,336,476
Oats	3,081,990	3,490,490	4,281,150
Peas	218,068	542,637	743,118
Beans	436,033	244,376	996,006
Indian Corn, or Maize	2,076,918	6,151,931	4,563,553
Wheatmeal and Flour from—			
Hanse Towns	129,294	130,352	238,053
France	1,231,380	2,713,046	882,613
United States	108,694	164,735	106,272
British North America	14,136	6,142	6,584
Other countries	78,871	120,209	589,550
Total Wheatmeal and Flour	1,562,375	3,134,484	1,823,072

The importation of wheat in the first six months of 1867 shows a considerable excess over the amounts imported in the corresponding periods of two preceding years,—that excess being 25 per cent. over 1866; 93 per cent. over 1865. Russia continued to supply about a third of the whole; and Prussia, whence a much less quantity was received in the previous year in consequence of the war, supplied about a fourth of the total amount. From France the supply, which was large in 1866, has been lately inconsiderable; while that from the United States, though still comparatively small, has increased. Sixty per cent. of wheat imported in the last half-year came from the Russian and Prussian dominions. The principal supply of wheat-flour is from France; and in the first half of the current year it was greatly diminished. For in the same period of 1865 French flour was 79 per cent. of the whole quantity; in that of 1866 it was 86 per cent.; and this year only 48 per cent. The supply from some other countries increased.

QUANTITIES of BRITISH WHEAT SOLD in the Towns from which Returns are received under the Act of the 27th and 28th VICTORIA, cap. 87, and their AVERAGE PRICES, in each of the first SIX MONTHS of the Years 1862-67.

	QUANTITIES IN QUARTERS.					
	1862.	1863.	1864.	1865.	1866.	1867.
	quarters.	quarters.	quarters.	quarters.	quarters.	quarters.
First month ..	220,266	262,923	344,930	300,816	212,713	221,791
Second month	242,229	239,882	306,713	298,271	259,999	203,900
Third month (five weeks)	277,410	281,405	350,974	373,069	331,295	280,878
Fourth month..	173,174	243,552	285,286	261,501	250,159	205,231
Fifth month ..	185,356	267,587	284,601	327,694	250,890	221,067
Sixth month (five weeks)	208,042	302,897	333,201	283,528	245,393	196,985

	AVERAGE PRICES PER QUARTER.											
	1862.		1863.		1864.		1865.		1866.		1867.	
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
First month ..	61	4	47	5	40	7	38	6	45	10	61	5
Second month..	60	0	47	3	40	8	38	3	45	7	60	11
Third month (five weeks)	59	3	45	8	40	1	38	6	45	4	59	9
Fourth month..	58	0	45	7	40	0	39	8	44	10	61	7
Fifth month ..	58	0	46	4	39	2	41	0	46	3	64	8
Sixth month (five weeks)	54	7	46	8	39	8	41	5	48	3	65	5

AVERAGE PRICES of BRITISH CORN per Quarter (imperial measure) as received from the INSPECTORS and OFFICERS of EXCISE according to the Act of 27th and 28th VICTORIA, cap. 87, in each of the first TWENTY-SIX WEEKS of the Year 1867.

Week ending	Wheat.		Barley.		Oats.		Week ending	Wheat.		Barley.		Oats.	
	s.	d.	s.	d.	s.	d.		s.	d.	s.	d.	s.	d.
January 5 ..	60	2	43	6	24	2	April 6 ..	61	2	39	7	23	9
January 12 ..	61	0	43	5	24	2	April 13 ..	60	9	39	9	24	5
January 19 ..	62	3	44	5	23	4	April 20 ..	61	4	39	8	25	5
January 26 ..	62	2	45	9	24	5	April 27 ..	62	11	39	1	25	6
February 2 ..	62	6	45	2	24	6	May 4	63	10	39	9	25	3
February 9 ..	61	4	45	3	24	9	May 11 ..	64	9	38	11	25	10
February 16	59	10	43	9	23	6	May 18 ..	64	11	38	11	27	0
February 23	59	11	43	4	24	3	May 25 ..	65	3	37	10	26	2
March 2 ..	59	8	42	4	24	8	June 1	65	5	37	9	26	10
March 9 ..	59	3	41	5	24	1	June 8	65	4	36	9	27	4
March 16 ..	59	4	41	5	24	9	June 15 ..	65	9	36	2	27	8
March 23 ..	59	9	40	5	24	8	June 22 ..	65	8	35	0	27	7
March 30 ..	60	11	39	6	24	11	June 29 ..	64	10	35	3	28	0
Average of Winter Quarter	60	7	43	1	24	4	Average of Spring Quarter	64	0	38	0	26	3

The Average Prices of Consols, of Wheat, of Meat, and of Potatoes; also the Average Number of Paupers relieved on the *last day* of each Week; and the Mean Temperature, in each of the Nine Quarters ending June 30th, 1867.

Quarters ending	Average Prices.					Pauperism.		Mean Temperature.
	Consols (for Money).	Wheat per Quarter in England and Wales.	Meat per lb. at Leadenhall and Newgate Markets (by the Carcase).		Best Potatoes per Ton at Waterside Market, Southwark.	Quarterly Average of the Number of Paupers relieved on the *last day* of each week.		
			Beef.	Mutton.		In-door.	Out-door.	
1865	£.	s. d.						°
June 30	90⅝	40 6	4¾d.—6¾d. Mean 5¾d.	6½d.—8½d. Mean 7⅜d.	90s.—115s. Mean 102s. 6d.	125,846	776,016	56·2
Sept. 30	89⅝	43 3	4½d.—7d. Mean 5¾d.	6¼d.—8¾d. Mean 7½d.	65s.—100s. Mean 85s.	117,172	719,589	62·5
Dec. 31	88⅛	44 10	4½d.—7d. Mean 5⅝d.	5½d.—8¼d. Mean 6⅞d.	60s.—90s. Mean 75s.	129,036	725,259	46·0
1866 Mar. 31	87	45 6	4½d.—6¾d. Mean 5⅝d.	5½d.—7¾d. Mean 6⅝d.	55s.—90s. Mean 72s. 6d.	139,546	759,402	41·2
June 30	86⅛	46 6	4¾d.—7d. Mean 5⅞d.	5½d.—8½d. Mean 7d.	60s.—95s. Mean 77s. 6d.	123,657	734,139	53·0
Sept. 30	88¾	51 0	5¼d.—7½d. Mean 6⅜d.	5½d.—8¼d. Mean 6⅞d.	75s.—120s. Mean 97s. 6d.	120,955	717,553	58·9
Dec. 31	89⅛	56 8	4¾d.—7d. Mean 5⅞d.	5¼d.—7½d. Mean 6⅜d.	85s.—130s. Mean 107s. 6d.	133,979	734,312	46·2
1867 Mar. 31	90⅞	60 7	4¾d.—7d. Mean 5⅞d.	5d.—7¼d. Mean 6⅛d.	115s.—160s. Mean 137s. 6d.	147,620	832,364	38·9
June 30	92⅛	64 0	4¾d.—6¾d. Mean 5¾d.	5¼d.—7¼d. Mean 6¼d.	135s.—175s. Mean 155s.	134,678	779,629	53·5

Average Prices of British Wheat, Barley, and Oats, per Imperial Quarter, in each of the Fifteen Years 1852-66.

Year.	Wheat.	Barley.	Oats.	Year.	Wheat.	Barley.	Oats.
	s. d.	s. d.	s. d.		s. d.	s. d.	s. d.
1852	40 9	28 6	19 1	1860	53 3	36 7	24 5
1853	53 3	33 2	21 0	1861	55 4	36 1	23 9
1854	72 5	36 0	27 11	1862	55 5	35 1	22 7
1855	74 8	34 9	27 5	1863	44 9	33 11	21 2
1856	69 2	41 1	25 2	1864	40 2	29 11	20 1
1857	56 4	42 1	25 0	1865	41 10	29 9	21 10
1858	44 2	34 8	24 6	1866	49 11	37 5	24 7
1859	43 9	33 6	23 2				

The AVERAGE PRICES of CONSOLS, of MEAT, and of POTATOES, and also the AVERAGE NUMBER of PAUPERS RELIEVED on the *last day* of each Week, in each of the YEARS 1857-1866.

Years.	Average Price of Consols (for Money).	PAUPERISM. Average Number of Paupers relieved on the *last day* of each week.		AVERAGE PRICES OF Meat per lb. at Leadenhall and Newgate Markets (by the Carcase).		Best Potatoes per Ton at Waterside Market, Southwark.
		In-door.	Out-door.	Beef.	Mutton.	
	£.					
1857	$91\frac{7}{8}$	121,669	737,287	$4\frac{1}{4}d.$—$6\frac{1}{2}d.$ Mean $5\frac{3}{8}d.$	$4\frac{3}{4}d.$—$7d.$ Mean $5\frac{7}{8}d.$	108s.—134s. Mean 120s. 8d.
1858	97	120,140	751,031	$4\frac{1}{4}d.$—$6\frac{1}{4}d.$ Mean $5\frac{1}{4}d.$	$4\frac{1}{2}d.$—$6\frac{3}{4}d.$ Mean $5\frac{1}{2}d.$	104s.—136s. Mean 120s.
1859	95	110,703	705,590	$4\frac{1}{2}d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{2}d.$	$4\frac{3}{4}d.$—$7d.$ Mean $5\frac{7}{8}d.$	79s.—109s. Mean 94s.
1860	94	110,603	687,763	$4d.$—$6\frac{5}{8}d.$ Mean $5\frac{3}{8}d.$	$5d.$—$7\frac{1}{8}d.$ Mean $6d.$	120s.—145s. Mean 132s. 6d.
1861	92	122,600	720,366	$4d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{4}d.$	$5d.$—$7\frac{1}{4}d.$ Mean $6\frac{1}{8}d.$	114s.—134s. Mean 124s.
1862	$93\frac{1}{2}$	130,974	820,953	$4d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{8}d.$	$5d.$—$6\frac{3}{4}d.$ Mean $5\frac{7}{8}d.$	125s.—149s. Mean 137s.
1863	$92\frac{7}{8}$	129,934	859,751	$4\frac{1}{4}d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{4}d.$	$4\frac{3}{4}d.$—$7d.$ Mean $5\frac{7}{8}d.$	90s.—110s. Mean 100s.
1864	$90\frac{3}{8}$	126,753	788,689	$4\frac{1}{2}d.$—$6\frac{1}{2}d.$ Mean $5\frac{1}{2}d.$	$5\frac{3}{8}d.$—$7d.$ Mean $6\frac{3}{16}d.$	64s.—86s. Mean 75s.
1865	$89\frac{5}{8}$	127,589	758,199	$4\frac{1}{2}d.$—$7d.$ Mean $5\frac{3}{4}d.$	$5\frac{3}{4}d.$—$8\frac{1}{4}d.$ Mean $7d.$	75s.—101s. Mean 88s. 5d.
1866	$89\frac{7}{8}$	129,534	736,351	$4\frac{3}{4}d.$—$7d.$ Mean $5\frac{3}{4}d.$	$5\frac{1}{2}d.$—$8d.$ Mean $6\frac{3}{4}d.$	69s.—110s. Mean 89s. 6d.

PAUPERISM.

The annual return of the number of paupers in England at the beginning of the year shows that on the 1st of January, 1867, the number was 963,200, being 1 in 21, or 4·8 per cent. of the actual population, and an increase of 38,387, or 4·2 per cent., over the number at the corresponding date in 1866. The details which follow do not absolutely agree with the above statement, owing to 810 paupers having been in receipt of both indoor and outdoor relief. The indoor paupers on the 1st of January, 1867, were 148,195; the outdoor 815,005. 201,511 were men, 411,136 women, 345,877 children; 416,310 were able-bodied, 501,124 not able-bodied, 41,090 insane; and 5027 vagrants. Of the able-bodied, 41,729 were men, and 116,579 women; and 258,002 children were relieved with their parents classed among the able-bodied adults; of the not able-bodied, 142,193 were men, 271,864 women; 87,067 children; and of the insane, 17,589 were men, 22,693 women, 808 children. The number of able-bodied adult paupers relieved was 158,308, an increase of 8988, or 6 per cent. over the number on the 1st of January, 1866. Receiving indoor relief there were 47,049 men, 46,276 women, 51,304 children, 3566 vagrants not otherwise classed; or classing otherwise, 41,936 able-bodied, 92,176 not able-bodied, 10,517 insane, 3566 vagrauts.

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ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

I.—*The use, to the Farmer, of a Magnifying-glass or Simple Microscope.* By W. Kencely Bridgman, L.D.S.,R.C.S., Eng.

Prize Essay.

Upwards of five-and-thirty years' experience in the almost daily use of the microscope for investigating subjects of natural history leads me to speak with some degree of confidence as to the benefit that this instrument may confer upon the farmer, by enabling him first to enter into the minutiæ of the wondrous contrivances ordained by the Creator to maintain life, health, and succession in organised beings, and next to turn that knowledge to account, by seconding the more recondite operations of nature in those processes wherein his interests are most concerned.

Through neglect of such a resource, bad or defective seed may cause the loss of a season's growth; crops may be wasted by the ravages of disease, which might have been stayed had it been sooner detected; while by its adoption adulteration in feeding-stuffs, manures, and various other substances, may be brought to light, so that the farmer may be no longer at the mercy of the manufacturer or the dealer. He may also gain much insight into the mode and principles of vegetable growth, of inflorescence and fructification, upon which the quantity and quality of grain depends, and by watching the influence of manures and other substances upon plants, he may learn the right time and manner of applying them, as well as the appearances of disease in its incipient stage and subsequent development, together with the action of all such preparations as either check or eradicate it. All these observations come within the province of the microscope, and they are essential to the full development of agriculture as a science.

The magnifying-glass or microscope must not, however, be mistaken for other than it really is—that is only "a means to an end;" for it *teaches* us nothing, it only affords us the power of examining objects too small for the naked eye, and thus

places those that are wholly invisible, or but slightly visible in the ordinary way, on an equality with larger structures for the purpose of examination. For instance, if we mix together a handful of beans, peas, wheat, oats, or any other of the larger seeds, any ordinary observer could sort out the different kinds with the naked eye, but to name them correctly would require previous knowledge. But if we substitute for these the grains of three or four different kinds of starch or pollen, no human eye, if unaided, would be able to detect the difference between them, although under the microscope this case would prove quite as practicable as the former. As, however, the objects to be examined *de*crease in size, so must the magnifying power be *in*creased in proportion; hence a range of powers becomes requisite; and as these magnifying glasses vary in description, a short account, with diagrams of some that would prove serviceable to the farmer, has been appended to this paper, together with some few hints to novices and students as to the selection of glasses, the preparation of objects, and the choice of books of reference. It must, however, be borne in mind, that there is no royal road to knowledge, and in this respect the use of the magnifying-glass is not an exception; *its successful application must be acquired by practice.*

One of the first subjects for which the farmer would probably seek the aid of the magnifying-glass would probably be the seed required for sowing. Every species of seed, and almost every variety of each species, will be found to possess some difference in appearance, either of colour, size, or external marking, that will at once give it a distinctive character. In numerous instances the external tracery upon the *testa*, or skin of the seed, furnishes not only a beautiful microscopic object, but a means of identification. Henbane, tobacco, poppies, anise, and carraway, will serve as good illustrations of this fact, while each of the different species of *silene*, or catch-fly, will exhibit not only a strong family likeness, but likewise sufficiently distinctive traits to at once determine it specifically. It is almost impossible to obtain a correct idea of these characteristics in any other way than by actual observation; hence all the seeds used by the farmer, as well as those of the common weeds, should be rendered familiar to him by examination and study.

Defects and impurities in samples of seed fall under two heads:—

1st. Genuine seed, but barren or unripened; or, again, extraneous substances that will not grow, added to increase bulk.

2nd. Other kinds of seed capable of growth, the plants from which would be undesirable or injurious to the crops or land.

The strongest plants being derived from fully developed and

well ripened seeds, it will be the first consideration that the *bulk* of the sample shall consist of such. The character of these will be at once caught by the eye, and singled out as a prominent feature. A small quantity being taken into the palm of the hand, and a magnifying-glass, proportionate to the size of the seed, being used, a tolerably fair estimate may be made of the entire sample, and any extraneous substances that are not seed at once detected.

For the larger seeds a common hand magnifier will be sufficient, but for the more minute a much greater magnifying power will be required, at least until the observer shall have become perfectly familiar with the objects; it is a well known fact that the faculty of recognising minute objects turns in a great degree upon *familiarity* with them, so that upon intimate acquaintance even very minute objects are readily recognised at a mere glance with a common lens. Such an acquaintance, however, can only be gained by the use of higher magnifying powers, hence the *compound* microscope, to be hereafter described, which answers the purpose both for the low and high powers, becomes an essential requirement.

In the case of "grass seeds," in which one or more varieties of trefoil are commonly combined with various species of grasses, properly so called, the use of the microscope is important, because much of that which is sold under this name, consists principally of the sweepings of the hay-loft, and consequently is not *ripened* seed; and it is only by the aid of a microscope that this can be detected. The first step will be to get rid of the minute seeds * and other small objects by sifting. After this has been done the different kinds of trefoil will be readily made out, but the different species of grass, although varying in size and form, are not easily discriminated, although by practice much may be done. To give a practical illustration of such use of the microscope:—To get at the seed of grass, in order to ascertain whether it be well ripened or not, it will be necessary first to get rid of the "outer husk or chaff-scale," which is the peculiar calyx of grasses and plants allied to them. To accomplish this it will be desirable to have them thoroughly dried by heat, so as to render the chaff brittle, it will then crumble away on being rubbed between the finger and thumb, and leave the seed clean and fit for examination. Damping the

* A farmer in this neighbourhood sowed several acres with grass, and, to his vexation, the land became covered with the *Lychnis Dioica*, or Campion, which cost him considerable trouble and loss. He has since expended some twenty guineas in the purchase of a first class microscope, and affirms that this would not have happened if he had previously owned the microscope, adding that it "*certainly would never happen again.*"

seeds after they have thus been dried will sometimes render the plump ones more conspicuous.

"Doctored" seed ranks as one of the impurities comprised within the first division. When *scalded* seed has been mixed with choice varieties of turnip-seed, a practised eye will be able to detect them on carefully examining the hilum or germ of the seed, which is killed by the treatment. In the case of over-year turnip seed that has been "renovated" in the oven, a similar examination will be likely to expose the deception. If trefoil seeds have been "oiled," or shaken in a greasy bag, dust will be found sticking to the surface (especially if a little dust be shaken over them), which is not the case when they possess only their own natural gloss.

The bulk of the seed is made up of farina or starch, and gluten. The latter, when soaked in cold water, swells so that the grain may easily be crushed, or cut into thin slices, so as to show its internal structure. The quantity of starch-cells and their quality may thus be readily observed, and the quality of the grain or seed judged of by its richness in starch grains.

The embryo, which lies at the depression called the scar the spot at which growth commences, should be carefully examined, as seed that has begun to sprout from damp, and has then been checked, is wholly useless for sowing. The hilum or scar is the spot at which it is attached to the seedpod or receptacle, and where the nourishment enters it from the coverings or seed vessel. When the seed is fully ripened, it separates of itself, and a cicatrix is formed which offers a distinctive indication that the seed has been matured. It is also at this spot that the moisture enters when the seed swells preparatory to growth and also where the first sprouts of the future plant protrude. The state of this cicatrix, whether it be minute and perfect, or has been enlarged and shrivelled, are the points to be examined and a comparison of good dry seed with some that has been sprouted and then dried, will show most clearly in what this difference of appearance consists.

With respect to "feeding-stuffs," it will be far more difficult to obtain satisfactory results than with seeds, because these substances being crushed or ground, the particles, *although admitting of recognition by a practised eye*, do not present so marked a difference. In the coarser kinds, the magnifying lens [illegible] detect well-known bodies, but the medium powers of the compound microscope will be needed in most cases. The material if solid, as oilcake, should be broken down into a coarse powder, and a portion examined both dry, as an opaque object, and in water, as a semi-transparent one. A piece of oil cake broken small, and placed in a basin, should have a quantity

of hot water poured upon it, which after a short time may be strained off, leaving the husks and coarser parts for examination.

The shining exterior of the flax seed will be conspicuous, and contrast greatly with the dull husk of the cotton-seed, while the farina of each may be learned by practice. Dr. Arthur Hill Hassall, in his work on 'Adulterations Detected,' observes that "the microscope is specially suited to the detection of organised structures or substances, and that by its means one kind of root, stem, or leaf may generally be distinguished from another, one kind of starch or flour from another, one kind of seed from another, and so on . . . . The seeds even belonging to different species of the same genus may frequently be distinguished from each other by the microscope, a point in some cases of very great importance." To show the importance of such discrimination, the following instance may be cited: "Some cattle were fed with rape-cake, and died with symptoms of inflammation of the stomach and bowels. Nothing of a poisonous nature could be detected on analysis, but it was suspected the cake might be adulterated with mustard husks, although even this point could not be clearly established by chemical research. Under these circumstances the cake was sent to the author (Dr. Hassall) for examination, who had but little difficulty in ascertaining that it was adulterated with mustard seed, which, from the large quantity consumed, was doubtless the cause of the fatal inflammation. So great and manifest are the differences revealed by the microscope in different vegetable substances, that with ordinary care and some amount of preliminary knowledge, the discrimination becomes a matter of the greatest ease and the most absolute certainty."

Manures.

The microscope will scarcely enable any *inexperienced observer* to learn much of the composition or quality of manure, although with practice much may undoubtedly be done. The inorganic bodies, such as sand and ashes, may readily be seen. Any organic substance, as sawdust, or other vegetable offal, may also be detected; and if a portion be washed in a very small quantity of boiling water, and a drop or two of this solution then suffered to dry on a glass slide, the peculiar salt or salts may be learned by their form, as every particular salt, or combination of salts, has its specific configuration and arrangement, which by the aid of the polariscope will at once become apparent. A knowledge of the form and characters of these salts is, of course, implied in such an investigation. Blood, fish-offal, and other similar substances may likewise be made out by careful manipulation.

The genuineness of guano may also be learned through the presence of certain flinty remains of organic bodies, which are peculiar to the different deposits. Straw of wheat, oats, grass, and many other vegetables, contain certain arrangements of flint in their substance that are left entire after all vegetable matter has become decomposed and washed away. These flinty and imperishable remains of vegetable organisms that have existed in the sea, and have either served directly as food for the penguins, or previously filled the stomachs of fishes and molluscs on which they have preyed, being deposited with the excrement which forms the guano beds, are the characteristic features of the best guanos. Says a late eminent Professor, "When examined microscopically, a great abundance of beautiful silicious skeletons of *diatomaceæ* are found amongst it; and curiously enough, the best samples of guano contain the greatest number of these remains, which," says the late Professor Quekett, "were first detected by my late brother in 1845." * "Now when we consider," says the same writer," the vast amount of silica that must be removed from the soil with the straw of wheat, barley, oats, and other grasses, it must be evident that a supply of this substance ought to be restored to the soil to insure good crops; hence it follows that the value of good guano as a manure may depend not entirely upon its ammonia, lime, and potash, but in a certain degree also upon the silica it contains." It is not improbable that the superiority of farmyard manure may depend very greatly upon the silica that the hay, corn, and straw contain, which *is but sparingly appropriated by the animal.* It may also arise from a deficiency of silica that the straw of corn is often weak, and breaks down under the weight of the ear. The exterior surface of straw, canes, &c., derive their fine polish, as well as their strength, from a layer of flint, as may be proved by boiling them in nitric acid.

For the process of obtaining these remains from guano, and the flint from the stalks and leaves of plants, &c., the reader is referred to the valuable little work of Mr. Davies on the "preparing and mounting objects for the microscope," † which is a complete manual on the subject at a small cost. For an examination of these silicious remains the ¼-inch or ⅕ of an inch object-glass will be required, and a very accurate adjustment of the light must be obtained to bring out their very beautiful patterns in a satisfactory way. Of sand, loam, turf-ashes, and

* Quekett's 'Histology,' vol. i. p. 59.

† 'The Preparation and Mounting of Microscopic Objects,' pp. 151, by Thomas Davies. 8vo., 2*s*. 6*d*. Hardwicke.

other such like additions, there will be little difficulty in detecting the presence, by a little practice.*

Disease, as Affecting the Roots, Stems, or Leaves of Plants.

It may be considered a rare circumstance to find any one of these parts affected in any way by disease not arising from local injury, without at the same time the whole plant being out of health. We are apt to consider the pulling off a diseased leaf, or the cutting out a withered stem a sufficient remedial treatment, but were the *rootlets* to be examined microscopically it would soon be seen that something *here* too was wrong. It is an important question open for investigation whether all diseased formations in plants do not commence with an abnormal action at the tips of the rootlets, due to some change within the soil itself, such as undue dryness, sudden accession of a superabundance of moisture, the application of stimulating manure, either *too strong*, or *applied when the plant is not in a condition to receive it.* The moral of this is that the moment anything may be seen to be going wrong, let the rootlets be at once carefully examined, and a note made of the condition of the soil at the time, as to openness, compactness, or dryness, as also of the treatment which the land may have received just previous to the discovery. An admirable paper on the growth of the wheat plant, by the Hon. and Rev. Lord Sidney Godolphin Osborne, is published in the 'Transactions of the Microscopical Society for 1857,' in which this subject is very fully treated; it is illustrated with drawings of the various parts of the roots and rootlets in their different states and stages, and is well worthy the careful attention of the agriculturist. The experiments were performed in many ways, the plants growing in various materials, and with different kinds of solid and fluid manures, under the higher powers of the microscope (from the $\frac{1}{4}$ inch to the $\frac{1}{8}$ inch), and the actual process of growth was thus witnessed, and its actions noted. "The general conclusion," observes the author, "at which I have arrived is, that though what I call the epidermic plasm does absorb moisture from the soil—in fact, requires moisture to preserve its elasticity, combining in the formative matter it secretes some of the matters presented to it, in whatever medium it may grow—still the great

* Mr. Norman, of Hull, well known both as a naturalist and a merchant, who has especially studied diatomaceæ, writes, "A little experience will soon show, that whereas certain forms of diatomaceæ are peculiar to the Peruvian, other species are only detected in the Bolivian; while Ichaboe, Californian, Saldanah Bay, and Patagonian guanos contain forms which indicate their former habitats with unerring certainty."—P. H. F.

sources of plant health and strength are obtained by means of the capsules or spongioles, the *termini* of every root and rootlet, and also by the absorbent cells ever found at the extremities of the numberless suckers; for it is at these points that I find the cell-structure very greedily taking in whatever foreign matter I have succeeded in introducing into the *media* in which I have grown the plants. The action of anything placed in the medium in which plants grow which is injurious to them, is at once shown by its action upon their roots and lateral processes, the capsules losing many of the characteristics of healthy action. . . . There can be no doubt but that the plant requires not only certain chemical constituents to secure its health, but that these must be offered to it when growing in a medium, allowing the utmost freedom to the capsules of the roots, rootlets, and to the suckers. . . . . I am satisfied a highly pulverised poor soil would grow better plants than a close, hard, tenacious soil, however fertilised."

It is, then, to the terminal points of the roots and rootlets that the inquirer's attention must be directed, and for this purpose the microscope is invaluable, as affording at a cheap rate that information which obtained in the field on a large scale becomes a costly experiment.

The discovery of a patch of fungus upon the leaf or stem of a plant must not be taken for a *cause* of injury to the plant; it *generally* only indicates a want of vital action, and is the consequence of decaying organic matter. Fungi are rarely, if ever, found on *healthy* surfaces, but it is a law of nature that nothing stands still; if a plant be growing freely and healthily, it holds its own, and no sporadic fungi find a location, but the moment vital action flags or ceases, either from decreased vital energy, or from local injury, a lower order of vegetation instantly commences to obtain a sway. Mildew generally shows itself after a season of active growth, followed by an inequality in the supply of moisture from the soil and from the atmosphere. In other words, when from drought but little moisture finds its way *into the system through the medium of the roots*, such amount being insufficient to maintain a full and active circulation *within the plant*, and when the vital action thus becomes sluggish, the dews and damp of the night air overbalance it, and the germination and growth of fungi then commences.

Fungi are known to be rapidly developed during and immediately after a thunderstorm, owing, it is supposed, to the nitrogenous compounds formed in the air, as a result of these electrical discharges. Hence upon this hypothesis the application of a stimulus to the roots should take place whenever any excessive stimulus is being derived from the atmosphere. Growth

accelerated by means of artificial stimulants should be *gradually attained*, and as *gradually reduced*, care being taken to maintain a healthy action during the season of comparative rest, and to maintain an even balance of root action and atmospheric stimulus.

The cell-structure of vegetable growth should be carefully studied, as the "cell" is the fundamental unit, by a repetition of which even the largest forms are constructed, and hence the life of the cell is the life of the plant, and death of a part may be followed by the death of the whole, unless a sufficient amount of reaction can be started.

The "mycelium" of a fungus may sometimes be traced running through every part of a plant, and under these circumstances the death of the plant invariably follows. It may sometimes be traced only in the bark, or the epidermis, and then be of less consequence. In these investigations the higher powers of the microscope, as well as some acquaintance with the character and habits of the parasitic fungi are indispensable.*

But the roughness or scabbiness of roots and stems is often caused by other than fungous growths; it sometimes arises from injuries inflicted by the puncture or presence of insects —the larvæ of flies and beetles; at other times it may be produced by some injurious and irritating cause connected with the soil. A small transverse slice cut very thin by means of a sharp razor, and examined in water between two pieces of glass, will show the disposition of the cells both healthy and injured, and how far the latter extend, or are connected with the general structure. Transverse sections of the leaves taken through a diseased spot, and examined edgewise, show also to what extent the cells of a leaf may be affected by disease.

The leaf itself is an important study, and requires some little amount of patient investigation to be thoroughly understood, but without this knowledge it is utterly impossible for any one to appreciate the exquisitely beautiful and delicate offices it has to perform, and the means by which its functions are carried on.

STARCH-CELLS.—If a *very* thin slice from the interior of a healthy potato be placed between two pieces of glass, squeezed out, and then examined with a magnifying glass, there will be seen an infinite number of little oval shining bodies of many different sizes. These are starch-cells, and should form almost

* A knowledge of these may be acquired by the aid of M. C. Cooke's 'Plain and Easy Guide to the Study of Microscopic Fungi.' 8vo., coloured figures, price 6s. Hardwicke.

the entire bulk of the tuber, as may be seen from the following sketch, while the diagram by the side of it shows the conditio

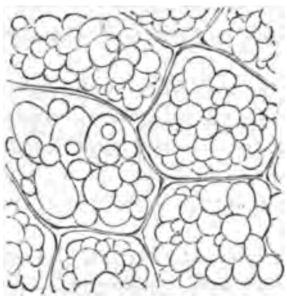

Fig. 1.—Healthy Potato, showing starch *in situ.*

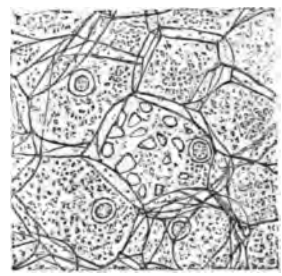

Fig. 2.—Diseased Potato, showing absence of starch.

of a diseased tuber in which the starch is wholly wanting, indi cating the absence of the power of forming starch as one of th features of the disease. An examina tion of the tuber at many differen stages during the growth of the plan may lead to a better knowledge of th means of promoting healthy growth.

Fig. 3.—Diseased Potato, with fungus.

The annexed figure shows a portio of diseased potato with the mycelium o a fungus permeating it in all directions

Starch in wheat differs from that o the potato in outward appearance, and is similarly liable to variation in quan tity and quality.

The following diagram (from Que kett's 'Histology') shows the relative sizes of different kinds o starch, and also a cell of rhubarb filled with starch-grains *in situ*

Wheat-starch is peculiar in having a number of large, and almost round cells interspersed with a great number of smalle ones of very different appearance, and some few intermediate i size. The large ones are flattened, but the smaller ones are somewhat globose or elongated.

The granules of oat-starch are compressed like the large granules of wheat-starch, but have a slight tendency to being angular, although they have no external markings.

The starches of the dicotyledonous plants—such as beans peas, vetches, &c.—have a peculiar character quite different fron the preceding forms. Those of beans are large, with an indente outline, as if about to divide into three or more globula granules.

The starch of peas has the same general character as that of the bean, but is smaller, and has a deeper central furrow, from which the indentations appear to spring.

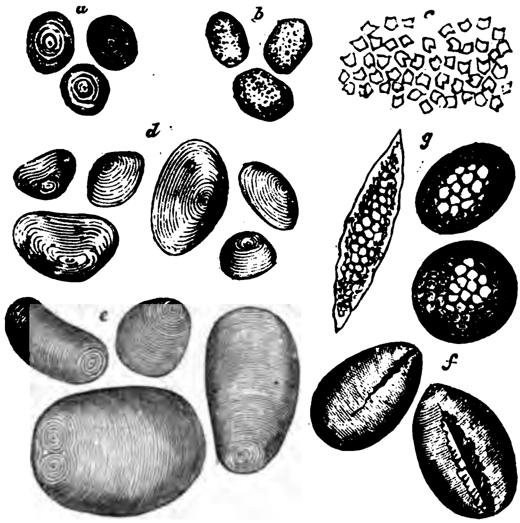

Fig. 4.—*a.* Wheat starch. *b.* Sago meal. *c.* Rice starch. *d.* Potato starch. *e.* Tous les mois. *g.* Rhubarb cells, containing starch.

From these characteristics it will be easy to determine whether wheaten flour has peas or beans ground up with it. A small portion moistened with water and spread thinly between two glasses is all the preparation needed. To obtain the starch from beans, peas, oats, maize, or millett, &c. &c., these should be soaked in *cold* water until soft, and then a small portion scraped or sliced may be treated as above.

Arrowroot, sago, tapioca, oatmeal, &c., all afford characteristic forms of starch, and should be closely studied. Starch may also be obtained from numerous other sources among the roots and bulbs ordinarily grown for agricultural or domestic purposes, and as the value of all starch-forming growth necessarily depends upon the quantity and quality of the starch-cells produced, the influence exerted on this growth by various agencies is important.

Textile Fabrics.—In the investigation of textile materials the microscope has been found of incalculable advantage. "At a recent meeting of the Quekett Microscopical Club a paper was read on the application of the microscope to the discrimination of vegetable fibres, to point out what had been done, what remained to be accomplished, and to suggest the best mode of per-

forming it. Although adulterations of food have been carefully investigated, adulterations or admixtures in fabrics, whether of animal or vegetable origin, have hitherto obtained but little attention. Yet, it is urged, the subject is an important one, and well deserving systematic research.

"All fibres employed for commercial purposes may be divided into four classes, two of which are animal—i.e. wool and silk—and two vegetable, which may be termed vascular." *

The first representation is that of cotton (*a*), Fig. 5.† The fibre of cotton is a cellular hair, which may be recognised by its forming a flat and slightly twisted band with apparently thickened edges. "Very important investigations on this subject have been commenced in Manchester," and the question is asked "Are there really any distinguishable microscopic differences between Sea Island and Egyptian, New Orleans and African, or between Brazilian and Surat?"

Wool (*b*) has a peculiar structure, readily to be distinguished from all other animal and vegetable fibres, and differing slightly

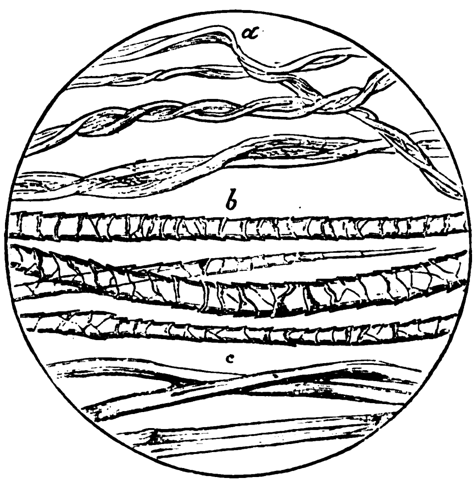

Fig. 5.—*a.* Cotton. *b.* Wool. *c.* Silk.

in its own varieties, as may be seen by reference to a paper on "Hairs." ‡ To this peculiar scaly structure that wool possesses so

* Hardwicke's 'Science Gossip,' No. I. vol. ii. p. 10, 'a Monthly Medium of Interchange and Gossip for Students and Lovers of Nature,' price 4*d.* This publication contains much varied and trustworthy information, that would prove serviceable to the farmer.

† To Dr. Forbes Watson we are indebted for the use of the blocks which illustrate this part of the subject.

‡ 'Science Gossip,' vol. i. p. 29.

strongly, is due the property of "felting," and by the extent to which this character is developed in different hairs their value for the purpose is regulated. Thus, in the examination of wools, this feature should be noted, as well as the coarseness or fineness of the fibre, its length and density. The peculiar markings which characterize wool in all its varieties, afford a safeguard against the possible admixture of other materials. Important evidence as to the effects of various disorders due to keep, climate, or mismanagement, as also on the influence which special kinds of food, or even the various "sheep dips" exert upon the fleece may be confidently anticipated from such investigations—results which will have an important bearing on the commercial value of wool.

Silk (*c*) is more uniform in character, and its several varieties are not readily, if at all, distinguishable.

Flax.—Fig. 6 (*a*). "Vascular fibres are derived either from the inner bark (the *liber*) of the exogenous, or the vascular bundles of the leaves of endogenous plants. The most important of these

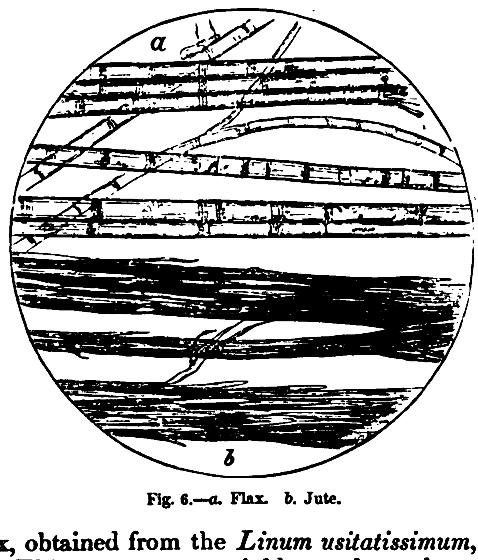

Fig. 6.—*a.* Flax. *b.* Jute.

fibres is flax, obtained from the *Linum usitatissimum*, or common flax plant. This possesses a variable market value, according to the climate or country of production. It is natural to inquire whether the microscope can detect differences between Irish and Belgian, or between Egyptian and Spanish flax."

Jute (*b*) has now become an article of extensive use, and its fibre, which is an "adulterant" in extensive use, can always be readily detected. It has a rough outline, and is much more

opaque than flax; it has no definite cross-markings, and the cells frequently terminate in a tongue-like shape.

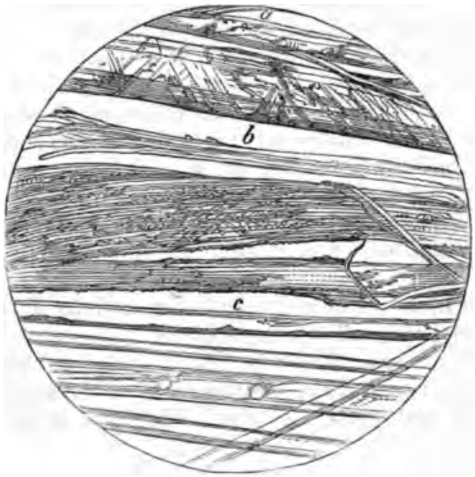

Fig. 7.—*a*. Chinese nettle. *b*. Neilgherry nettle. *c*. Bedolee.

Fig. 7 (*b*). Neilgherry nettle has been recommended, as a substitute, or for admixture with wool. A comparison of the figures (5 *b* and 7 *b*) will prove that such an admixture could readily be detected.

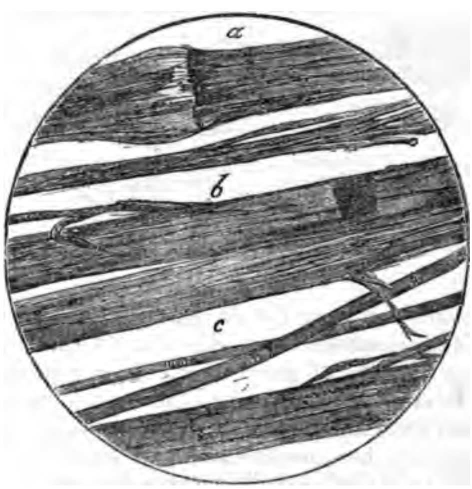

Fig. 8.—*a*. Barlala. *b*. Ambaree. *c*. Mudar.

Fig. 9.—*a.* Russian hemp. *b.* Himalayan hemp. *c.* Italian hemp.

Hemp.—The true hemp, *Cannabis sativa*, is well known; and Fig. 9 represents the microscopic appearance of three varieties: the Russian, Himalayan, and Italian. They are not unlike flax, except as to the transverse markings, which in hemp are usually defective, and, when present, less decided. It is difficult to distinguish some fine samples of hemp from flax.

Fig. 10.—Sunu, Jetee, Dunchee.

Jetee yields the Rajmahal bowstring-hemp, a fibre much valued for its tenacity.

We come now to the second group of vascular fibres, n those afforded by endogenous plants, of which the most im] is that afforded by the pine-apple. Under the microscoj

Fig. 11.—*a.* Pine-apple. *b.* New Zealand flax. *c.* Manilla hemp.

have a somewhat opalescent, glass-like appearance, and a refractive.

New Zealand flax (*Phormium tenax*) has a peculiar appearance under the microscope.

Manilla hemp, the produce of a species of plantain, p but little variation from other endogenous fibres, except presence of distinct cross-markings. Cocoa-nut coir an (Fig.12) are sufficiently distinct to render description unnec

It will be seen that the difference between cotton, woc cocoa-nut fibre, ejoo, jute, and flax, is of so marked a ch as to be readily distinguishable even by the veriest tyro, l diagrams representing Chinese nettle, Neilgherry nettle, l and t. hemps, show that the difference between them ... n such cases where the difference depends ... f the surface, tint, or degree of opacity, tl ... nd configuration of the object, illustratioı ... ance; yet such distinctions are readily ... ye from the object itself under micr ... l hence it is that a careful examination ... absolutely essential for acquiring a ... particular subject.

... seeds, &c., where size, shape, and m ... ame appearances, there is little to c

but where, as in the case of the above textile materials, no two pieces can be found sufficiently similar in outline to be mis-

Fig. 12.—*a.* Cocoa-nut coir. *b.* Ejoo.

taken for each other, or where substances are broken up into irregularly formed masses, these require to be studied with regard to the general form and character of the masses; as, for instance, whether they possess angular or rounded edges, or any particular direction for breaking up, or whether they are rough or smooth, dull or shining in the fracture, opaque or transparent. All or any one of these features may constitute the distinctive characters of a given substance, therefore particular attention should be directed to them; and, when these have been determined, diagrams may be employed to assist the memory; but it is very desirable that the objects themselves should be preserved for future examination and reference.

The Magnifying Glass or Microscope.

The construction of the magnifying glass, or microscope, varies according to the use for which it is intended; but the essential part consists of a highly polished piece of very clear glass, termed "a lens," which has one or more *curved* surfaces; an ordinary spectacle glass may be taken as the simplest form of a common magnifier of very low power: a *sphere* of glass, or of any other transparent substance, being the highest magnifier that can be obtained by one single piece. Thus, the more *convex* it is, the shorter is its *focus*; or in other words, the closer must the object and the eye be placed, to obtain a distinct vision, and consequently the more the object is magnified. The perfection that has been of late years attained in the construction of the microscope

has been effected by using a number of different pieces of gl
different qualities combined together, so as to do away with in
fections natural to a lens formed of one single piece of glass

Lenses are mounted as common hand magnifiers, in tortoi

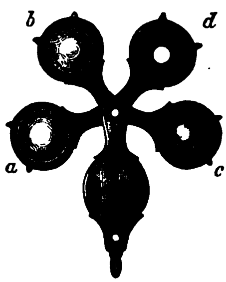

Fig. 13.

frames, folding up for the pocket. T
contain from one to three glasses of diff
powers, so arranged as to be used sing
combined; and a set, Fig 13, consisti
one-and-a-half inch, one inch, and half
focus, will be found very generally us
In addition to its use as a *hand* magn
Messrs. Smith, Beck, and Beck provi
stand, by which it can be made into a sir
but very useful, single microscope, as sl
in the accompanying illustration taken
their catalogue.

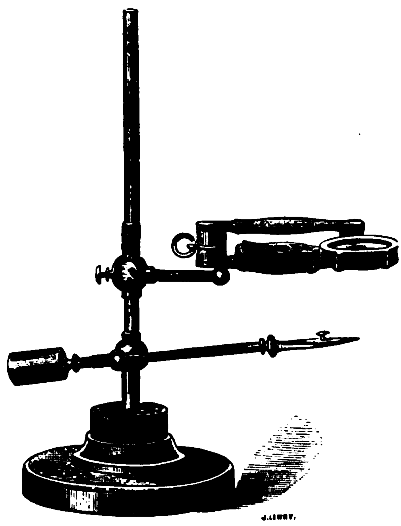

Fig. 14.

When a higher power is required in a single lens, the Stan

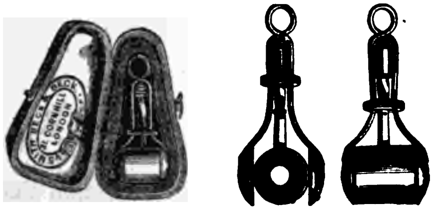

Fig. 15.

and Coddington (so n
after their inventors
sometimes had rec
to, they are mounte
metal case for the v
coat-pocket or w
guard.

The disadvantage of *small* glasses of *short* focus is that they have to be held close to the eye, and the object close to the glass, which causes a degree of strain to the eyes that is both disagreeable and dangerous to the eyesight. These, however, are now almost wholly superseded by the *compound* microscope, wherein this defect is entirely overcome. A much greater additional advantage is also gained by substituting the latter for the *single* magnifier. When the utility of the magnifying-glass has been once found out, it almost invariably leads to a craving for greater power, so as to obtain a still further enlargement and better view of the object under examination. The principle of the single glass does not admit of any very great increase of this magnifying power, while with the compound arrangement the limit of the enlargement is, as yet, scarcely known, and as now constructed, modern achromatic instruments* are so contrived as to provide the highest as well as extremely low powers.

Since the common hand lens can be of but very limited use to the farmer, and is wholly inadequate to most of the purposes for which he ought to apply it, and as the manufacture of more perfect instruments has been brought to a great degree of perfection, at such comparatively small cost as to place them within the means of nearly every student, it has been deemed desirable to advert to their construction.

With a simple magnifying lens the object itself is seen through the glass. Not so, however, with the compound microscope. A convex lens has the property of forming *a picture* of any object presented to it, at some specified distance on its opposite side; thus in the annexed diagram the picture B is so much larger than A, the object itself, as the distance is greater between B and C (the lens) than between A and C. In the compound microscope, it is *not the object itself*, but this greatly enlarged picture, B, that is seen, being again magnified by another single lens; thus its twofold action of enlargement gives it a claim to be termed "compound."

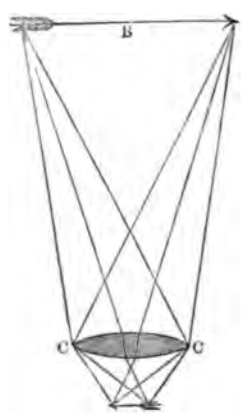

Fig. 16.

* Instruments having their imperfections corrected, although more strictly "without colour."

The marginal figure shews how this effect is accompl in the arrangement known as the "body" of the instru

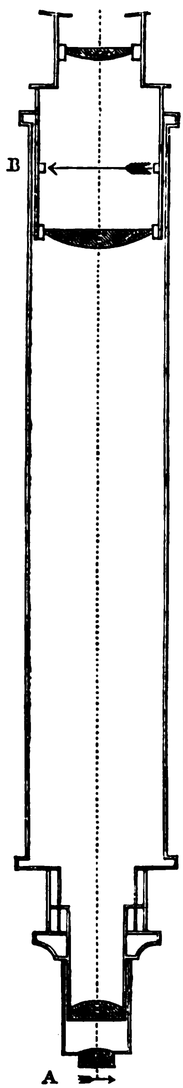

Fig. 17.

The object, A, being properly placed, sufficient light thrown upon it, an enl picture of it is seen at B. The large just below this picture is termed the field because it regulates the rays of light for the picture, while the topmost or eye-gla merely a single magnifying lens, th which the picture B is seen and fu enlarged. The distance of B from the glass is regulated by moving the object nearer to, or farther from the lens, whi termed the "object glass" just above it. lenses which are thus employed to pro the picture of the object, are mounte combinations for each power, each set contained in a separate brass fitting, w screws on at the lower end of the tube great care must be taken not to displa get these soiled by the fingers. The qu of a microscope depends greatly upon the lity of its object-glasses, and these are often purchased separately—a series of tw three being generally required—a 1-inch $\frac{1}{4}$-inch where 2 only are used; a 2-inch a $\frac{2}{3}$rd or $\frac{1}{2}$-inch, and a $\frac{1}{4}$ or $\frac{1}{8}$ where 3; an added where a higher power still is de The simple magnifier which is then us enlarge the picture in the eye is termed th piece, the form represented in the upper tion of Fig. 17, and again in Fig. 18, or three sizes of which are generally sup with the best microscopes. The upper gl this must be carefully wiped whenever th strument is used, as dust, and damp from eye tend to render it misty.

All additional arrangements of a micros are with a view to facilitate the proper pl and illuminating of the object to be see gether with the measurement of its le breadth, and thickness.

Different magnifying powers are obtain changing the lower lens or object glass, a series of whi represented in Fig. 18, and also by substituting shorter, th

higher magnifying eyepieces, two of which are also shown in the same figure.

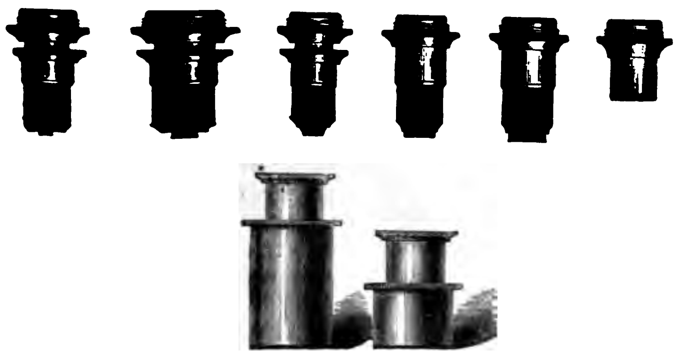

Fig. 18.

A cheap but strong and effective form of microscope has been introduced under the title of "Student's," and these are now sold by opticians at from 2 or 3 to 5 or 6 guineas. In most of these, strength and real usefulness has been more considered than high finish and unnecessary ornamentation, and for ordinary use they answer every purpose.

A very ingeniously contrived "pocket" microscope has recently been introduced by Mr. Moginie, at Mr. C. Baker's, which is cheap as well as portable (Fig 19).

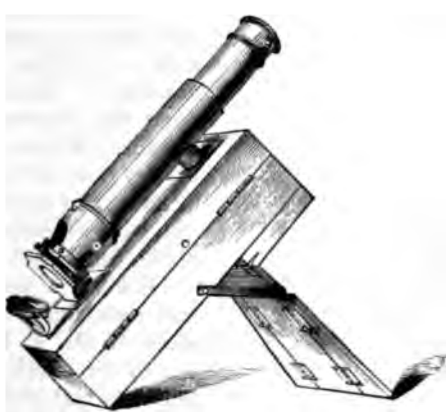

Fig. 19.

The most valuable invention of modern times in relation to the microscope is the "Wenham Binocular" (Fig 20). The use of *one* eye only at a time (which the common microscope involved) was

found to be injurious to the sight, because the eye *not* used always suffered more or less from the stimulus of light not being applied to it in the same manner and degree as to its companion. In the Binocular, as its name implies, both eyes are used, and the former drawback is overcome. The beam of light going from the object A to the picture B is divided by a glass prism placed half way across it, into two portions, one of which goes on as formerly, but the other is diverted and sent up a second tube attached to the first tube, forming a V, and thus two pictures, one for each eye, are formed and both eyes are stimulated equally. (See Fig 20).

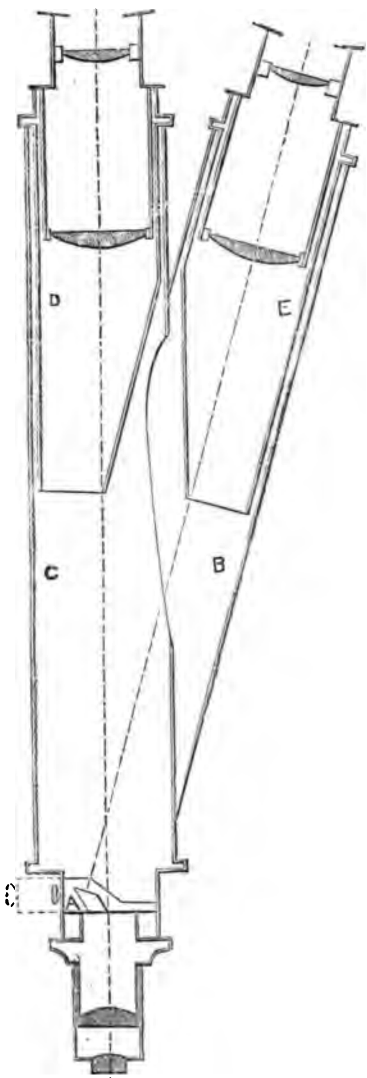

Fig. 20.

Next in importance to the optical part, or magnifying-glasses, is the stand, or frame-work carrying the glasses, by means of which the objects to be examined are held and adjusted for vision. Strength, steadiness, and free movement are essential. Freedom from tremor is absolutely indispensible, for upon this depends much of the comfort in observing, as well as the possibility of seeing at all, with the higher powers, any vibration tending to render the object indistinct.

One of the most substantial, and most complete is the No. 1A stand of Mr. T. Ross (Fig 21), which for excellence of workmanship and elaborate finish is scarcely equalled. It was originally devised with the especial aim of attaining steadiness and freedom from tremor, which it most effectually accomplishes. This is a large and massive as well as an expensive instrument, but where it can

be afforded it is an undoubted luxury. Most of the best of the cheaper kinds of stands are after this model, and those on a

Fig. 21.

Fig. 22.

smaller scale supplied by Mr. Ross, at a far more moderate cost, are excellent in every respect.

One point requiring attention is the position of the axis of suspension upon which the swinging part is balanced. I say "balanced" because a good instrument is so adjusted that whatever be the position to which it may be inclined, it has no tendency to move, but retains its balance. This is a point which many makers have overlooked, who produce stands that, when inclined back, require support to prevent their toppling over: it should be especially looked to when a selection for purchase is being made.

Useful instruments for ordinary purposes are now made with a smaller amount of work, and consequently at a far less cost, such is the 6*l.* Binocular of Mr. Baker, as represented above (Fig. 22). In this, good and substantial workmanship has been combined with a tolerably well arranged suspension.

Another form of cheap stand has been devised by Messrs. Smith, Beck, and Beck, and styled by them the Popular Microscope, which has special merits (Fig. 23). Extreme steadiness is obtained by supporting the lower end in a socket, and portability, by its folding up. Its price is moderate—that is, from 10*l.* to 15*l.* or 20*l.*, proportionate to the amount of apparatus supplied with it, all of which is of excellent workmanship.

Fig. 23.

Another cheap, and very convenient, binocular and polarizing microscope, invented by Dr Lawson has been brought out by

Mr. Collins, in which the contrivances for shifting the object-glasses and attaching the polarizing prism greatly facilitate use, and lessen the time and trouble generally taken up in attaching and changing glasses (Fig. 24). The peculiar eye-douche-like form of the caps of the eye-pieces, being of ivory, and forming a side-screen to the eyes, is well worthy of being generally adopted.

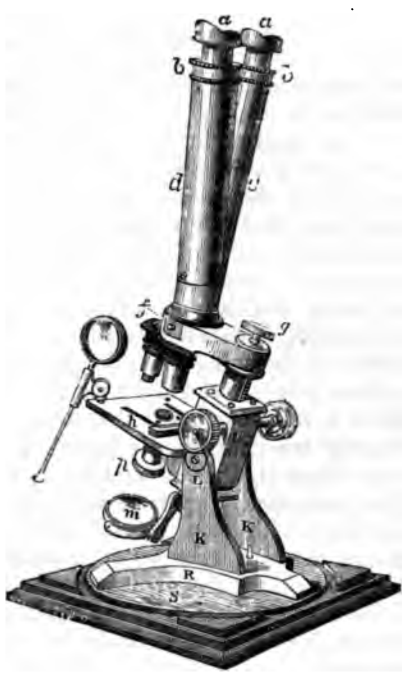

Fig. 24.

Many objects that are too delicate to exhibit their structure under ordinary light, become richly and beautifully coloured when seen with polarized light, and are then easily made out. Many animal and vegetable substances are remarkable for this property, but most, if not all, forms of lime in its crystallized state are thus readily now detected. No instrument is considered complete without its polarizing apparatus, and the facility with which this can be adjusted, in the present form, renders it a very desirable addition.

There are many other makers of good instruments, but sufficient has been said to point out the chief merits of such instruments, in a graduated series ranging in price from the lowest to the highest and most elaborately finished, so as to suit the means or inclination of different persons.* All the better class of instruments are now so constructed, that by obtaining a *well-made* stand in the first instance, which would be the most politic proceeding, any additional portions may be added at any time afterwards when required; and by the adoption of a universal screw, the object-glasses of all makers fit into any maker's instrument.

With respect to object glasses but little has been said, as it is always desirable to obtain the advice of, or to leave the selection to, an experienced microscopist. It should, however, be observed

* We are indebted to the various makers for the use of the blocks employed.

that *lowness of cost* does not imply cheapness, and should be on of the last things thought of in purchasing a microscope, as a certain amount of *good workmanship* is absolutely indispensable, and a stand lacking this, would after a very short time becom useless.

HINTS TO STUDENTS.

When an instrument has been selected, the next step will be t learn how to use it. There is one thing which must be constantl borne in mind from the very first, which is *never to touch th glasses with the fingers*, nor to wipe them with anything hard o rough: they should be brushed with a dry camel-hair penci when dusty, but when they require to be wiped, this should b done with a piece of clean and very soft washleather, kept o purpose, and carefully wrapped up from dust when not in use The use of the various pieces of apparatus will be best learne by obtaining a half-hour's instruction from an old hand. Th method of observing must be gained by practice after the studen has been put into the right way.

It is a well known fact that persons not accustomed to observ minutely see nothing distinctly on first looking into a micro scope—that is, although they may see the whole contour of th object presented, they take only a *general* view of it, and are no impressed with any special definite fact, such as could b referred to from memory afterwards, as a distinctive character istic. There is the greatest difference possible between *seein* and *observing*. Seeing is the rule, and observing the exception Place a piece of lichen-covered stone or wood in the hands o a dozen different persons, and it is more than probable that no one of them, ten minutes afterwards, would be able to say whethe it was red, blue, yellow, or green. Now, it is this habit o observing minutely and attentively, whether it be with th common eye-glass or with the highest powers of the microscope that is the first step to be attained. Some particular featur should be looked for, such as external shape, roughness o smoothness of surface, colour or peculiarity in form of marking &c., &c., and afterwards the same features should be looked fo in other kindred bodies, and *the differences noted and written dow if possible.*

By so comparing objects one with another, and looking out fo minute and trifling differences of structure, the faculty of *observin* —of detecting slight distinctions and of taking in, almost at single glance, all the leading features of an object—may be rapidl gained if set about in the right manner. When once it ha become a habit, a solid foundation is laid for reliable results to b drawn from subsequent investigations. A careless and fault

habit has too often led to the propagation of erroneous statements, and the only safe way of learning is by *a careful study of objects themselves as the preliminary step*, any reference to drawings or engravings being reserved for after comparison and verification. Always bring the object to be thus studied into the centre of the field of view.

The best practice is to commence upon any common objects that may be met with, such as seeds, sand, table-salt, &c., examining them separately at first, and then mixing them so as to obtain a view of several objects together. Portions of the flowers and leaves of plants afford an almost unceasing fund of instruction, whether in their healthy or diseased state.

It is always desirable to obtain first with a low magnifier, a good general idea of the structure or composition of any object before submitting it to higher powers, and to increase the enlargement by degrees—using first an inch-and-a-half object-glass, then a two-thirds or half-inch, a quarter-inch, &c., as required.

To facilitate the changing of these object-glasses, and to prevent the loss of time that would arise from having to screw each one off and on separately each time a different power is required, a contrivance called a "double nose-piece" is very often had recourse to. This consists of two arms attached to the lower part of the body of the instrument, having one power attached to each end, and, being made to turn on its centre, either one may be brought into its place by merely causing the arms to describe one-half of a circle, and thus either power may be changed for the other in a few seconds. Treble and quadruple nose-pieces are also made, but are not so commonly used as that which carries two powers only, the lower power serving also to "find" the object for the higher one.

It is important to have a microscope always ready for use at a moment's notice. Fig. 24 is shown as fixed down upon a board having a circular groove intended to admit the rim of a glass shade, which, together with a piece of wash-leather thrown over the eye-pieces, would be a sufficient protection from dust, and only require lifting off to leave the instrument fit for use. A wooden cover, or a bag made of glazed calico, might be adopted as an inferior substitute.

The diseases of plants are so intimately associated with the laws of vegetable life that a superficial acquaintance with the ordinary external appearance of disease in either roots, stems, or leaves, cannot be of the slightest avail unless something be known of the principles of vegetable physiology—*i.e.* of the structure and function of the several parts of the plant in their "normal," or natural and healthy state. To acquire this know-

ledge, diligent use of the compound microscope is indispensable, accompanied by some work on histology or vegetable physiology as a guide to the mode of investigation.

Diseases are also supposed to be produced by fungi, such as mildew, rust, &c., but these growths are rather indicative of disease elsewhere. When the normal condition of the cell structure, of the root fibres, leaf-cells, and other parts of the plant are known, the mycelium of these fungi may be recognised and sometimes traced all through the structure. To comprehend the nature and arrangement of these fungous pests of vegetable life every part of the plant should be carefully examined for their presence.

The structure of the leaves also bears a marked significance as to the mode of treatment plants ought to receive; the hairs and glands upon their surface, the stomata on one or both sides, are all connected with the laboratory within the substance, and have their respective functions to perform, any cessation of which becomes the precursor of disease. Portions of the upper or under skin of the leaf may be stripped off with a sharp knife and placed wet between glasses so as to be ready for examination. The internal structure of the leaf is best seen by taking a very thin section by means of a razor across the thickness of the leaf, and thus getting an edgewise view of it and the hairs, &c., which are connected with it. Sections made with a sharp razor may be taken from all parts of the plant so as to afford a considerable amount of knowledge of its peculiar structure.

Dry and hard seeds, such as peas and beans, &c., after being thoroughly softened in water, may likewise have thin slices shaved off in the same manner. For the method of preserving these and other substances the reader is referred to the before-mentioned manual of Mr. Davies on mounting, &c.

All small seeds may be preserved in a very simple manner when required only for reference. Take a strip of any common card, or stiff paper, cut to 1 inch wide and 3 inches long, which is the standard size of microscopic object-slides. In the centre of this put a little thick gum, or thin flour-paste, and drop on it a heap of the clean dry seeds, and after a few minutes shake off all that are loose; put aside till thoroughly dry, and, if preserved from dust and damp, they may be kept for years. A collection should be made of the seeds of all common weeds, but more especially of those that are particularly obnoxious or injurious to crops or pasture.

All materials such as wool, hair, vegetable fibres, starch, pollen, very minute seeds, or dust of any kind, if required dry, may be preserved between two pieces of glass fastened together by paper pasted upon them; but these are more commonly first

soaked in turpentine and then covered with Canada balsam, for the manner of doing which directions will be found in the 'Manual for Mounting,' &c.

Specimens of various samples of linseed-cake, cotton-cake, rape-cake, &c., after having been treated with hot water, should be put up either dry or in balsam, being at the same time very carefully labelled with date, name, and any particulars of manufacture, purchase, or effect in use, that may be connected with them. Samples of crushed seeds known to be unadulterated should be procured and preserved in the same way, as these afford the only reliable evidence of the respective characters of each, and will at once prove the presence of extraneous substances in manufactured cake.

In the examination of seeds, &c., and in the preparing substances for examination under the microscope, it is mostly necessary to have the means of using the hands at the same time that the object is seen under a magnifying glass, and for this purpose the lens and holder, Fig. 14, may be used, but a convenient form of stand called a dissecting microscope is provided on purpose, where every facility for manipulation has been studied.

Dr. Lawson's Binocular Dissecting Microscope.

The most recent and best contrivance is the above binocular dissecting microscope of Dr. Lawson as made by Mr. Collins of Tichfield-street.* In this both eyes are used, which gives the object a more natural appearance, and, both hands being at liberty, objects may be separated from one another, and vegetable

* See 'Science Gossip' for September 1, 1865, p. 201.

substances pulled to pieces or cut up so as to obtain a clear insight into their general formation.

In putting up specimens for preservation some kind of magnifying glass is always needed. It is, however, in the preparing parts of objects, so as to be able to get a good view of the part required to be seen, that the dissecting stand is absolutely essential; for more perhaps depends upon the rightly displaying the object than in the after examination of it.

Specimens of seeds and numerous other substances that would be found useful to the farmer for reference, may, for a very trifling sum, be purchased of the opticians, who are supplied by persons whose sole occupation consists in preparing and mounting objects for the microscope. These object-preparers will assuredly be ready to provide an ample supply of specimens to meet all the requirements of the farmer, should the microscope become generally resorted to, as it most probably will be at no very distant day.

II.—*On the Changes which take place in the Field and in the Stack in Haymaking.* By Dr. Augustus Voelcker.

If grass or clover could be made into hay without undergoing any change in composition, the hay, when made, would no doubt be found as valuable as the green food from which it was derived. From exposure to the broiling heat of the sun on a hot summer's day, cut grass or clover hardly lose anything else but water, neither do their constituents undergo material alterations if the grass is not much bruised, and the drying process takes place with sufficient rapidity. The green colour, sweet taste, and aromatic smell of well-made hay plainly show that such is the case, and that haymaking is not always or necessarily attended with serious loss of nutritive matter. I am aware, however, that many practical men maintain the opinion that grasses and clovers are less nutritious as hay than when consumed green: though this may be true as a matter of fact in nine cases out of ten, I conceive this is not a matter of necessity, but, if it were always practicable to resort to artificial means of desiccation, or to have under complete control the natural drying process in the field, no material loss would be experienced; the green colour of grass would be preserved, nothing but water escape, and all the solid constituents remain behind in much the same state of combination in which they occur in the succulent produce of our grass-fields.

No attempt has been made as yet to apply artificial drying

processes to haymaking on a large scale, and I question much whether, in ordinary farm practice, it is worth while seriously to entertain suggestions for drying grass by artificial heat, dry currents of air, or the combined action of these two agents. The special question whether sewage grass grown in the immediate neighbourhood of large towns can be profitably made into hay by artificial means, remains yet to be solved. In ordinary farm practice haymaking, in a trying season like the last, will probably always be subject to more or less of waste in feeding substance; it becomes us therefore to inquire how far the loss can be mitigated, if not avoided. To this end it will be useful to trace, somewhat in detail, the nature and extent of the injury which grass sustains in haymaking, since hitherto little has been done in this direction. Such losses are generally traceable:—

1. To prolonged showery weather after the grass has been cut, so that it ultimately gets wet and half-dried, and has to be moved frequently on the ground before it can be carted and stacked.
2. To bad management in the field, and subsequent heating in the stack.
3. To the mistake of cutting the produce either too early or too late in the season.

Prognostications of the weather are, to say the least of them, very deceptive, and though the sun may be shining when the grass is cut, predictions as to the continuance of fine weather cannot be relied upon. Over one great cause of loss the farmer then has little or no control; it is not so, however, with the two remaining causes; though it is to be feared that injuries thus done to hay are too frequently put down altogether to bad weather.

1.—*Unpropitious Weather during the Haymaking Season.*

Grass and clover, when ready to be cut down, contain a considerable quantity of sugar, gum, mucilage, albuminous and other soluble compounds, which are all liable to be washed away by heavy showers of rain. As long as grass is still quite fresh, rain falling upon it has little or no injurious effect, for fortunately a coating of waxy or fatty matter covers the epidermis, and wraps, so to speak, the whole vegetable matter in a waterproof mantle. Rain for this reason may fall for days on newly-cut grass without doing any injury to it; but the case is very different if, by repeated turnings, the crop has become more or less bruised, and rain then descends upon the half-made hay: not only are sugar, gum, and other soluble matters then liable to be washed out, but the bruised state of the plants, admitting at least a partial diffusion of the various constituents through the

lacerated cell-walls, induces fermentation, which, if not ch at once, causes further loss. During the fermentation s albumen and sugar are destroyed—two of the most val elements of nutrition. In showery weather, grass recentl should, for this reason, not be turned over more than is lutely necessary, and under all circumstances it is des to handle the crop as lightly as possible, in order that i not get much bruised. That the loss in our hay crop, these circumstances, is at times great, scarcely admits of a and it is to be regretted that there are no experiments on which exhibit in figures their exact amount. Instead of anal results I am able, however, to give a practical illustration the use of some clover hay which was made in very wet we in some experiments tried upon sheep. With a view of taining the practical feeding value of several articles of f supplied weighed quantities of different foods to six p Cotswold sheep, each containing four animals. To one pens nothing but this clover-hay, cut into chaff, was When first put up for experiment on the 9th Novembe four sheep weighed respectively:—

	lbs.
No. 1	96
" 2	101
" 3	99½
" 4	93
Together	389½

During the first fortnight each sheep received 1½ lb. of c hay chaff per day, and care was taken to provide also water.

At the end of the fortnight the four sheep were put weigh-bridge, and then weighed:

	lbs.
No. 1	95
" 2	100
" 3	98½
" 4	91½
Together	385

Finding that all four sheep had lost in weight I gave during the next fortnight, 2 lb. each per day. On the December they weighed:

	lbs.
No. 1	94
" 2	101
" 3	98
" 4	88
Together	381

Thus, notwithstanding the larger amount of food, the sheep had lost together 4 lbs. since the last weighing.

Knowing that the clover-hay was made in wet weather, and long on the ground before it was carted and stacked, and having experimentally found a fair allowance insufficient to support the live weight of one sheep, I next gave them as much of the same hay as they would eat, and instead of cutting the clover into chaff as before, supplied it as taken from the stack. The food not consumed was weighed back each day, and found to consist mainly of the harder and less palatable stems of clover. From the 8th of December to the 14th, the four sheep ate 78½ lbs. of clover; in the next week 79 lbs., and in the next 76 lbs.; then 78½ lbs.; from the 4th of January to the 11th inclusive, they consumed 74 lbs., and in the following week 64½ lbs.; then again 73½ lbs., then 63½ lbs.; and in the last experimental fortnight 76½ lbs. in one week, and 63 lbs. in the last.

The periodical weighings of the four sheep are incorporated in the following Table :—

Sheep.	When put up for Experiment.						Loss −. Gain +.
	Nov. 9.	Dec. 21.	Jan. 4.	Jan. 18.	Feb. 1.	Feb. 15.	
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
No. 1 ..	96	95	93	94½	95	96	..
" 2 ..	101	100	100	102½	105	105	+4
" 3 ..	99½	98	98	98½	100	99	−0½
" 4 ..	93	89	85½	85½	87	87½	−5½
	389½	382	376½	381	387	387½	Total −2

This experiment is interesting in two ways. It shows first the folly of supplying animals with bad hay alone, and proves secondly that clover-hay can get deteriorated by rain, long keeping and frequent turnings in the field, to such an extent that any amount which sheep will consume is barely sufficient to maintain their original weight. Messrs. Lawes and Gilbert have shown that sheep fed upon well-made hay alone, increase in weight. The experiment, it will be seen, was continued for a period of more than three months, and the weighings done by myself in person. These practical results illustrate more forcibly the serious injury to which clover is subject when made into hay under an unfavourable season, than any analytical data possibly can do. Having, however, made a partial analysis of the clover, I may as well point out its general composition.

Composition of clover-hay injured by rain and badly made—

		Dried at 212° Fahr.
Moisture	20·45	..
Nitrogenous organic matter ..	8·50	10·69
Non-nitrogenous substances ..	64·27	80·79
Mineral matter (ash)	6·78	8·52
	100·00	100·00
* Containing nitrogen	1·36	1·71

I regret that I did not determine at the time the percentage of woody fibre nor the amount of matters soluble in water. However, the comparison of the preceding analysis with that of well-made clover-hay sufficiently indicates the very inferior character of the clover employed in the feeding experiments.

On an average, good clover-hay contains:—

Moisture	16·60
*Nitrogenous substances	15·81
Non-nitrogenous substances	60·00
Mineral matters (ash)	7·59
	100·00
* Containing nitrogen	2·52

Although the percentage of nitrogen in food does not afford invariably the means of determining with anything like accuracy its relative feeding value, in the case of clover-hay a very low percentage of nitrogen always indicates inferior quality, for as the leaves and more succulent portions of clover are much richer in nitrogen than its hard stems, a small percentage of nitrogen shows that the more delicate, brittle, and more nutritious leaves have been wasted to a great extent in the process of haymaking. Compared with good clover-hay, the injured sample contained little more than half the amount of nitrogenous or flesh-forming matters, and was no doubt rich in indigestible woody fibre.

2.—*Loss by bad Management in the Field, and subsequent Fermentation in the Stack.*

Although haymaking is a simple operation, yet experience and judgment is required to decide when to cut the grass, when to handle, and when to stack the hay.

I have seen farmers spending labour in turning hay on overcast days, on which a dew-point hygrometer showed the air to be nearly saturated with moisture, proving that evaporation could not possibly take place at the time, and rain might be expected at any moment. In such a state of the atmosphere it is not only

useless, but positively injurious, to knock about half-made hay, for it tends to bruise it and to render it more liable to be attacked by the rain of which the barometer, or more decidedly the hygrometer, has given previous warning. Frequent turnings of half-made hay should be avoided, especially in the case of clover, when the finer and more nutritious parts, the small leaves, are particularly liable to be knocked off by clumsy handling.

It is further well known that hay, when badly made in the field, loses subsequently in the stack both in weight and in quality; but the nature of the changes which it undergoes when it heats or ferments in the stack are not so well understood; it may, therefore, not be amiss to describe them as briefly as possible. Let me direct attention to a second analysis of good clover or meadow-hay, drawn up more in detail by Professor Way:—

Average Composition of Clover-hay.

			Dried at 212° Fahr.
Moisture	16·60	....	..
Fatty matters	3·18	....	3·81
*Albumen and similar nitrogenous compounds (flesh-forming matters)	15·81	....	18·96
Gum, sugar, mucilage and carbon hydrates readily convertible into sugar	34·42	....	41·27
Indigestible woody fibre (cellulose)	22·47	....	26·95
Mineral matter (ash)	7·52	....	9·01
	100·00		100·00
* Containing nitrogen	2·53	....	3·03

The preceding analysis represents the average of 75 varieties of clover, and a few other plants which are usually found amongst clover-seeds. Since these varieties differ much amongst themselves, corresponding differences in composition must be looked for in clover-hay, according as one species or another prevailed in the field on which it grew; the time of cutting will also much affect the result. The above figures, therefore, admit only of a *general* application. Clover-hay generally absorbs and retains a little more water than common meadow-hay under the same circumstances, and when in good condition contains more sugar, gum, and analogous compounds than meadow-hay, from which, moreover, it is chiefly distinguished by a much larger proportion of nitrogenous or fleshforming matters.

Taking the mean of twenty-five analyses of common meadow-hay, we obtain the following:—

Average Composition of Meadow-hay.

		Dried at 212° Fahr.
Moisture	14·61	..
Wax and fatty matters	2·56	2·99
*Albumen and other nitrogenous compounds (flesh-forming matters)	8·44	9·88
Sugar, gum, starch and similar compounds (respiratory substances)	41·07	48·09
Indigestible woody-fibre (cellulose)	27·16	31·80
Mineral matter (ash)	6·16	7·24
	100·00	100·00
* Containing nitrogen	1·35	1·58

Hay, whether produced from clover or natural grasses, evidently contains a good deal of ready formed sugar or soluble organic matter, having an analogous composition, and readily convertible under the influence of ferments, first into sugar and afterwards into alcohol and carbonic acid. These constituents are essential elements in all liquids and moist substances capable of entering into fermentation. No less essential are albumen, gluten, and other nitrogenous compounds. Some of the nitrogenous matter in hay occurs in a soluble, some in a condition insoluble in water. Soluble albumen and all albuminous compounds exposed for a short time to air and moisture, are readily transformed into ferments, that is to say agents which play the same part as yeast in setting up fermentation in sugary compounds. It appears that when a vegetable juice ferments, the admission of the air is necessary to the commencement of the change which then goes on, even if the air be afterwards excluded. Ferments almost invariably contain the germs of minute fungi, which become rapidly developed and multiplied in the measure in which the fermentation proceeds. Albuminous compounds that have been exposed for a short time to the influence of the air, as in ordinary ferments, are only capable of acting as inducers of fermentation when in a state of decomposition. This explains satisfactorily why hay that has been subject to excessive fermentation generally is very innutritious, such a great loss of flesh-forming [illegible] constituents, being implied by ferment[illegible]

[illegible] explanation of the fermentation of sugar has [illegible] given by Liebig. Ferments, the great German chemist says, being in a state of decomposition, have their constituent particles in a state of motion, and by commúnicating, mechanically, an impulse or motion to the particles of sugar, destroy the balance of affinities to which its existence is owing, and thus [illegible] balance or equilibrium more stable under

existing circumstances. The elementary particles of the sugar being disturbed in their previous arrangement, group themselves according to their individual affinities; and while the carbon forms on one side, a compound containing all the hydrogen (alcohol) it yields, on the other a compound containing the greater part of the oxygen (carbonic acid).

Alcoholic or vinous fermentation may thus be briefly described as the breaking-up of sugar under the influence of ferments, and the reconstruction of the constituent elements of sugar into alcohol and carbonic acid.

Another condition favourable to fermentation is an elevated temperature. If the thermometer ranges from 65° to 80° Fahr., fermentation proceeds with rapidity, whilst at a lower temperature it goes on more slowly, and is stopped altogether at 32° Fahr.

In the absence of a sufficient amount of water many substances otherwise capable of entering into fermentation remain apparently unaltered for a long period. Too much or too little water is alike unfavourable to the process. If one part of sugar is dissolved in three or four parts of water, and yeast is added, and the sugary liquid then placed in a warm room, no fermentation takes place, although three of the essential conditions have been fulfilled. Such a solution will require to be diluted with about an equal weight of water, in order to set up active fermentation. On the other hand, sugar dissolved in, say 16 to 20 parts of water, after the addition of yeasts, either ferments but very slowly, or rapidly turns acid in a warm place.

These facts have a direct bearing on the proper conservation of hay. As long as grass and clover are still quite fresh, the proportions of water to that of sugar in the green plant are too large to encourage fermentation; the nitrogenous constituents in newly-cut grass, moreover, only become ferments after the vitality of the plant has been destroyed, and the vegetable cells and vessels have become ruptured by partial drying, and their contents have been mingled together.

With the evaporation of water, and, to a certain extent, the more or less complete destruction of the living organisation of the plant, the conditions become more favourable for active fermentation. By degrees the drying crop arrives at a stage when the relative proportions of sugar and of the remaining moisture are most conducive to fermentation. Should the weather unfortunately turn showery at that stage of the haymaking process, and the air become saturated for many days and weeks together, the half-made hay often begins to ferment already in the field. When this takes place the hay loses in quality, and becomes much more liable to heat afterwards in the stack. If, on the contrary, fine and warm weather sets in, and evaporation pro-

ceeds with rapidity, the percentage of moisture soon sinks sufficiently low to prevent altogether, or greatly to retard, fermentation. The hay remains sweet, and shows far less tendency to heat in the stack, even if it actually contains more moisture than hay made in unfavourable weather. The more quickly the hay can be made in the field, and the less it gets bruised or loses colour there, the less likely it is to heat in the stack. However, much hay is injured when it is quickly made and in a fine season; it looks to be ready before it is so.

If dried ever so much or ever so carefully in the field, hay nevertheless heats to some extent in the stack. A slight fermentation, so far from being injurious, may be useful, for, as is well known, peculiar aromatic principles are thus generated, which certainly renders hay more palatable, and, it may be, more nutritious. As long as the green colour is retained, there is no danger of the hay losing in quality, but if the heat in the stack becomes so intense and continuous as to turn the hay decidedly brown, I have no hesitation in saying that considerable loss in feeding matter is incurred.

Some feeders of stock prefer brown hay to green, and it cannot be denied that the former often has a more aromatic smell and a more savoury taste than the latter. Although brown hay is much relished by stock, I do not think it desirable to put up hay so wet that it will afterwards turn brown in the stack; for, as I shall show presently, the sugar which is wasted when hay heats and turns brown in the stack, appears to me of greater value than the aromatic savoury substances which are generated by that process.

Some years ago I had an opportunity of examining brown hay which had a peculiarly aromatic, quite fruity flavour. It tasted decidedly acid, and contained scarcely any sugar, but a good deal of mucilage, soluble brown humus-like compounds, with but a small proportion of soluble albuminous matters. On further examination I found the acid in the hay to be acetic acid. The hay was very brittle, dark brown, and an analysis gave the following results:—

Composition of Brown Strongly-fermented Hay.

General Composition.

		Dried at 212° Fahr.
Moisture	18·33	..
Soluble organic matters	14·81	18·13
Soluble mineral matters	3·98	4·87
Insoluble organic substances	60·29	73·82
Insoluble mineral substances	2·59	3·18
	100·00	100·00

Detailed Composition.

			Dried at 212° Fahr.
Moisture	18·33	....	..
Fatty matters	1·70	....	2·08
*Soluble albuminous compounds	1·94	....	2·37
Mucilage, gum, brown extractive matters and traces of sugar	9·24	....	11·31
Acetic acid	1·93	....	2·36
Digestible fibre	23·01	....	28·19
†Insoluble albuminous compounds	8·75	....	10·71
Indigestible woody-fibre (cellulose)	28·53	....	34·93
Soluble mineral substances	3·98	....	4·87
Insoluble mineral substances	2·59	....	3·18
	100·00		100·00
* Containing nitrogen	·31	....	·38
† Containing nitrogen	1·40	....	1·71

The occurrence of a considerable amount of acetic acid in this hay, and the all but complete absence of sugar, deserve a special notice. Vinegar-manufacturers are well acquainted with the fact that all sugary substances may be employed for the production of vinegar, and that in the so-called rapid vinegar process a dilute alcoholic liquid in the presence of a porous substance, such as wood-shavings or chopped straw, or under the influence of a ferment, is rapidly transformed into vinegar. Scientific chemists, moreover, have pointed out the relation which exists on the one hand between sugar and alcohol, and on the other between alcohol and acetic acid—the acid of vinegar—showing that the latter is formed by absorption of oxygen, in other words that acetic acid results from the oxidation of dilute alcohol. It is clear, therefore, that the acetic acid found in the heavier hay was produced at the expense of the sugar present in unfermented or only slightly fermented hay.

Subsequently I had an opportunity of examining a rick of clover-hay, which became so hot in the interior that it had to be disturbed. It had been made in a bad season, and was stacked when too moist. On removing the top-layers of the rick the vapours emanating from the heated hay were found to have a peculiar pungent irritating odour, which particularly affected the eyes. A chemist could not doubt for a moment that these irritating vapours were due to the volatile inflammable compound which has received the name of Aldehyd. The same pungent odour may be noticed in vinegar manufactories at a certain stage of the vinegar process, and it is well known that aldehyd is produced in abundance when weak alcoholic liquids are allowed to trickle slowly over wood-shavings kept loosely in perforated capacious vats freely admitting air. In this operation

a large surface is exposed to the air, and the alcohol transformed into aldehyd by oxidation. Alcohol consists of 4 equivalents of carbon, 6 of hydrogen, and 2 of oxygen, its composition consequently may be expressed by the formula $C_4\,H_6\,O_2$. By taking up 2 equivalents of oxygen from the air alcohol becomes changed into aldehyd with the production of 2 equivalents of water. This simple change may be represented as follows :—

$$\overbrace{C_4\,H_6\,O_2}^{\text{Alcohol.}} + \underset{}{\overset{\text{Oxygen from the Air.}}{2\,O}} = \overbrace{C_4\,H_4\,O_2}^{\text{Aldehyd.}} + \overset{\text{Water.}}{2\,H\,O}$$

Aldehyd thus differs from alcohol by containing 2 equivalents less of hydrogen. The principal interest with which aldehyd is invested arises from the facility with which it absorbs oxygen, in consequence of which it readily is transformed into acetic acid. The addition of 2 equivalents of oxygen to aldehyd is all that is required for this change, as will be seen from the following formula :—

$$\overbrace{C_4\,H_4\,O_2}^{\text{Aldehyd.}} + \overset{\text{2 Oxygen.}}{2\,O} = \overbrace{H\,O, C_4\,H_3\,O_3}^{\text{Acetic Acid.}}$$

This oxidation of aldehyd is accompanied with the evolution of much heat. If the supply of air be insufficient, the acidification of dilute alcoholic liquids or substances capable of entering into alcoholic fermentation may become so imperfect that the alcohol is merely changed into aldehyd—a product intermediate between alcohol and acetic acid; and as aldehyd is an extremely volatile substance, it may escape without becoming further oxidised into acetic acid. In the interior of a closely packed hay-rick in an active state of fermentation, in which the sugar is first converted into alcohol and carbonic acid, the supply of air is necessarily but limited, and hence it happened in the case before us that although the vapours of aldehyd emanating from the clover hay-rick were so overpowering as to render it unsafe for a man to stand on the rick, yet so little acetic acid was formed in the hay that I did not consider it worth while to determine the amount quantitatively.

My observations on the changes which badly-made hay undergoes in the stack show clearly that excessive fermentation destroys sugar, one of the most valuable constituents of hay, which passing first into alcoholic fermentation is finally lost, either in the shape of aldehyd or that of acetic acid, according as the supply of air is more or less copious.

A glance at the following Table will show that the hay, as containing 38 per cent. of water, was far too wet for stacking.

Composition of Strongly-fermented Clover-hay.

General Composition.

		Dried at 212° Fahr.
Moisture	38·02	..
Soluble organic matters	9·40	15·17
Soluble mineral matters	3·96	6·39
Insoluble organic substances	46·01	74·23
Insoluble mineral substances	2·61	4·21
	100·00	100·00

Detailed Composition.

Water	38·02	..
Fatty matters	·90	1·45
*Soluble albuminous compounds	1·88	3·03
Gum, mucilage, brown extractive matters, and a little sugar	6·63	10·69
Digestible fibre	15·55	25·09
†Insoluble albuminous compounds	8·12	13·11
Indigestible woody fibre (cellulose)	22·33	36·03
Soluble mineral matter	3·96	6·39
Insoluble mineral matter	2·61	4·21
	100 00	100·00
* Containing nitrogen	·30	·48
† Containing nitrogen	1·30	2·09

Apart from the large excess of water, the high percentage of indigestible woody fibre shows that this sample was of very inferior quality, and that the excessive fermentation to which it was subject in the rick destroyed much sugar as well as albuminous compounds. Bad as this hay was, it was by no means at its worst, for on further keeping in the stack it became reduced by degrees to a dark brown mass which crumbled under the fingers like snuff, and became only fit for the dunghill.

It is well, therefore, to remember that highly-fermented hay, which has passed through the acetous acid fermentation, on prolonged keeping in the rick undergoes a kind of slow combustion or eremacausis, in consequence of which compounds like those present in peat are formed, and much valuable feeding matter is entirely resolved into gaseous products.

It is to be regretted that we possess no precise data, showing the actual loss in substance from a given weight of fresh grass. To supply this deficiency I purpose to put up next season a weighed quantity of well and badly made hay into a small rick to ascertain from time to time the actual loss which the whole rick sustains, and at the same time to determine by analysis, at the time of the periodical weighing, of what the loss in weight chiefly consists.

3.—*Loss on cutting Grass and Clover either too early or too late in the Season.*

Practical men are agreed that the best time to cut our hay-

crops is the period when the grasses or clovers have just c flowering, and the lower parts of the stems show signs of dr up. The precise date at which grass should be cut, of coı will vary according to climate, season, soil, and manures ployed; neither is it possible to describe intelligibly the app ance of the crop when it thus attains maturity. However, crops are frequently seen in the fields which might with advan have been cut down a week or fortnight earlier, and occasion others are gathered in too soon; though a single week's di ence in the time of cutting may affect very materially both quality and the quantity of the produce. With a view to obtaiı some reliable data, calculated to throw light on the loss wl farmers sometimes unconsciously sustain by beginning the harvest either too early or too late, I tried a series of experim some years ago, at the Agricultural College, Cirencester, w a favourable opportunity presented itself in a remarkably and good clover-field resting on the great oolite formation. land was level and in a good agricultural condition, the cl was equally thick throughout the field, as far as could be juc by the eye, and grew luxuriantly.

The analysis of the soil and subsoil gave the follow results:—

Composition of Experimental Clover-field.

Surface Soil.

Moisture (when analysed)	1·49
Organic matter and water of combination	11·80
Oxides of iron and alumina	15·82
Carbonate of lime	10·37
Alcalies and magnesia	·64
Insoluble silicious matter (clay)	59·88
	100·00

Clay-subsoil.

Moisture (when analysed)	13·40
Oxides of iron and alumina	17·01
Carbonate of lime	7·05
Magnesia	·60
Sulphate of lime	·56
Potash and soda	1·06
Insoluble silicious matter (clay)	60·32
	100·00

The analysis, I need hardly say, is not a complete one, an merely given here in order to show that the clover grew good calcareous clay-soil, which was well suited for the crop.

Part of the field where the growth was most even was apart for experiment, and accurately divided into 12 plots, measuring exactly 1 pole (16½ feet square).

The clover on plot 1 was mown for the first time as earl

the 15th of April. A second cutting was made on the 28th of April, a third May 12th, the fourth May 26, the fifth June 10th, and the last June 30th.

The whole produce of each cutting was weighed at once in the field, and at the same time a fair average sample was taken in each instance for the determination of the amount of water, albuminous compounds, and mineral matters (ash).

My object in beginning to mow the clover so early in the season was to ascertain incidentally whether eating off the young clover early in spring, as is sometimes the practice on the Cotteswold hills when spring food is scarce, was attended with loss in food or not. But for this object there would have been no use in mowing the clover so early in the season.

On the 2nd plot, the first cutting was made on the 28th of April, and was followed by other cuttings on the same dates as those of plot 1.

	When Mown.				
Plot 3 was mown on ..	May 12	May 26	June 10	June 30	
Plot 4 ,, ..	..	May 26	June 10	June 30	
Plot 5 ,, ..	..	June 2	June 16	..	July 28
Plot 6 ,, ..	..	..	June 9	June 30	
Plot 7 ,, ..	..	..	June 16	..	July 28

On plots 8, 9, 10, 11 and 12 the clover was mown once, and on the following dates. Plot 8 June 23rd, plot 9 June 30th, plot 10 July 7th, plot 11 July 18, and on plot 12 July 28th.

The experiments thus extended over a period of 3½ months, and the periodical weighings and analyses of the different mowings were made at intervals sufficiently numerous to bring out with certainty any marked differences which were likely to occur either in the quality or the quantity of the produce at different times of the year.

The results of these experiments are incorporated in the following Tables, showing the composition and weight of the produce of each plot.

In the first Table the composition in two parts is given both of the fresh and dried clover at the 6 periods when it was mown.

The second Table shows the actual weighings of the fresh produce of each plot, the amount of dry matter contained therein, and the chief food-constituents which compose the dry substance of clover.

In the third Table the preceding tabulated results are calculated per acre, and in separate columns the amount of hay per acre is also given, assuming the latter to contain 16·7 per cent. of moisture, which is a fair average proportion in dried good clover-hay. The percentage of moisture in clover-hay, I may observe in

passing, varies a good deal with the state of the atmosphere. I‌i the same rick, I found one-year-old clover-hay to contain fron 18·20 per cent. of moisture in the colder and damper months o the year, and only 14·15 per cent. in the drier months. Clover hay, therefore, may be assumed to contain on an average abou one-sixth of its weight of water.

PLOT I. TABLE I.—CLOVER EXPERIMENTS.*

a. Composition of Fresh Produce in 100 parts.

	DATE OF MOWINGS.					
	First, April 15.	Second, April 28.	Third, May 12.	Fourth, May 26.	Fifth, June 10.	S Ju
Interval since former mowing..	..	2 weeks	2 weeks	2 weeks	2 weeks	3 '
	lbs.	lbs.	lbs.	lbs.	lbs.	
Moisture	82·25	80·10	82·20	79·30	80·10	7
*Albuminous compounds	2·68	4·25	3·94	3·19	4·12	
Non-nitrogenous substances ..	13·00	13·18	11·56	14·90	13·69	1
Mineral matter (ash)	2·07	2·47	2·30	2·61	2·09	
	100·00	100·00	100·00	100·00	100·00	1(
* Containing nitrogen	·43	·68	·63	·51	·66	

b. Composition of Produce dried at 212° Fahr.

*Nitrogenous substances	15·12	21·31	22·12	15·37	20·69	1
Non-nitrogenous matters	73·27	66·28	64·96	72·03	68·81	6
Mineral substances (ash)	11·61	12·41	12·92	12·60	10·50	1
	100·00	100·00	100·00	100·00	100·00	10
* Containing nitrogen	2·42	3·41	3·54	2·46	3·31	

TABLE II.—(Weight in lbs. of Produce in Plot 1.)

	DATE OF MOWINGS.						Tota
	First, April 15.	Second, April 28.	Third, May 12.	Fourth, May 26.	Fifth, June 10.	Sixth, June 30.	
Interval since former mowing	..	2 weeks	2 weeks	2 weeks	2 weeks	3 weeks	
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Fresh produce	28½	3½	18	10	9	7	76
Produce dried at 212° F.	5·05	·69	3·20	2·07	1·79	1·60	14·
Consisting of:—							
*Nitrogenous substances	·75	·12	·69	·31	·31	·25	2·
Non-nitrogenous substances	3·72	·49	2·10	1·50	1·30	1·18	10·
Mineral matter (ash)	·58	·08	·41	·26	·18	·17	1·
* Containing nitrogen ..	·12	·02	·11	·05	·05	·04	

TABLE III.—PRODUCE in lbs. of Plot 1, calculated per Acre.

	Date of Mowings.						Total.
	First, April 15.	Second, April 28.	Third, May 12.	Fourth, May 26.	Fifth, June 10.	Sixth, June 30.	
Interval since former mowing	..	2 weeks	2 weeks	2 weeks	2 weeks	3 weeks	
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
Fresh produce	4560	560	2880	1600	1440	1120	12160 lbs. = 5 t. 8 c. 64 lbs.
Produce dried at 212° F.	808·0	110·4	512·0	331·2	286·4	256·0	2304 lbs. = 1 ton 64 lbs.
Produce calculated as hay, containing 16·7 per cent. of moisture	969·6	132·4	614·4	397·4	343·6	307·2	2764·6 lbs. = 1 t. 4 c. 76 lbs.
*Nitrogenous matters ..	120·0	19·2	110·4	49·6	49·6	40·0	388·8 lbs. = 3 cwt. 52 lbs.
Non-nitrogenous matters	595·2	78·4	336·0	240·0	208·0	188·8	1646·4 lbs. = 14 cwt. 78 lbs.
Mineral matters (ash)	92·8	12·8	65·6	41·6	28·8	27·2	268·8 lbs. = 2 cwt. 44 lbs.
* Containing nitrogen ..	19·2	3·20	17·6	8·0	8·0	6·4	64·2 lbs.

Cut as early as the 15th of April, the clover, it will be seen, contained much more moisture than the cuttings on the 26th of May, 10th and 30th of June.

The first mowing also was poor in nitrogenous matter, and this poverty was due not merely to the greater amount of water, for the dry substance itself yielded only 2·42 per cent. of nitrogen, whereas the dry produce on June the 10th contained 3·31 per cent., and that of the 30th of June 3·10 per cent. of nitrogen.

By far the largest weight of clover was obtained at the first cutting, and comparatively little at the second; in the following fortnight, fine and warm weather having set in, the clover again grew vigorously.

Altogether plot 1 produced in the 6 mowings 5 tons 8 cwt. and 64 lbs. of fresh clover, or calculated as hay, 1 ton 11 cwt. 76 lbs. of clover-hay per acre.

The 2nd plot yielded the results contained in the following Tables (see pp. 46, 47).

In this plot—

1. The first mowing was much poorer in nitrogenous matters than all the succeeding cuttings.

2. The second mowing contained an unusually large amount of moisture. I must, however, explain that this arose in a great measure from a heavy dew which had fallen on the clover shortly before it was weighed in the field.

PLOT II. TABLE I.—CLOVER EXPERIMENTS.

a. Composition of Fresh Produce in 100 parts.

	DATE OF MOWINGS.				
	First, April 28.	Second, May 12.	Third, May 26.	Fourth, June 10.	Fi Jun
Interval since former mowing	..	2 weeks	2 weeks	2 weeks	2 w
Composition of fresh produce:—	lbs.	lbs.	lbs.	lbs.	l
Moisture	80·80	86·30	79·80	78·30	7
*Nitrogenous substances.. ..	2·88	2·69	3·86	4·12	4
Non-nitrogenous matters ..	14·41	9·29	13·73	14·85	1
Mineral matters (ash)	1·91	1·72	2·61	2·73	2
	100·00	100·00	100·00	100·00	10
* Containing nitrogen	·46	4·3	·61	·66	

b. Composition of Produce dried at 212° Fahr.

Composition of dry produce:—					
*Nitrogenous substances ..	14·93	19·62	18·87	19·01	1
Non-nitrogenous matters ..	75·13	67·83	68·21	68·41	6
Mineral substances (ash) ..	9·94	12·55	12·92	12·58	1
	100·00	100·00	100·00	100·00	10
* Containing nitrogen	2·39	3·14	3·02	3·04	

TABLE II.—PRODUCE of Plot 2 in lbs.

	DATE OF MOWINGS.					Tota
	First, April 28.	Second, May 12.	Third, May 26.	Fourth, June 10.	Fifth, June 30.	
Interval since former mowing	..	2 weeks	2 weeks	2 weeks	2 weeks	
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Weight of fresh produce	55	9¾	12	10	8	94¾
Weight of produce dried dried at 212° Fahr. ..	10·56	1·33	2·42	2·17	1·83	18·
Consisting of:—						
*Nitrogenous substances..	1·56	·25	·44	·37	·31	2·
Non-nitrogenous substances..	7·96	·92	1·67	1·53	1·30	13·
Mineral matters (ash) ..	1·04	·16	·31	·27	·22	2·
* Containing nitrogen ..	·25	·04	·07	·06	·05	

TABLE III.—PRODUCE calculated per Acre in Plot 2.

	Date of Mowings.					Total.
	First, April 28.	Second, May 12.	Third, May 26.	Fourth, June 10.	Fifth, June 30.	
	lbs.	lbs.	lbs.	lbs.	lbs.	
Fresh produce in lbs. ..	8800·0	1560·0	1920·0	1600·0	1280·0	15,160 lbs. = 6 t. 10 c. 80 lbs.
Weight of dry produce in lbs. (dried at 212° Fahr.)	1639·6	212·8	387·2	347·2	292·8	2929·6 lbs. = 1 t. 6 c. 16 lbs.
Produce calculated as hay (containing 16·7 per cent. of water	2027·5	255·3	464·6	416·6	351·3	3515·4 lbs. = 1 t. 11 c. 43 lbs.
*Nitrogenous matters ..	249·6	40·0	70·4	59·2	49·6	468·8 lbs.
Non-nitrogenous matters	1273·6	147·2	267·2	244·8	208·0	2140·8 lbs. = 19 cwts. 12 lbs.
Mineral matters (ash) ..	166·4	25·6	49·6	43·2	35·2	320 lbs.
* Containing nitrogen ..	40·0	6·4	11·2	9·6	8·0	75 lbs.

3. The first mowing made on the 28th of April yielded 55 lbs. of fresh, or 10¼ lbs. (in round numbers) of dried clover, whereas the first and second cuttings made on plot 1 with the same length of growth yielded only 32 lbs. of fresh, or 5¾ lbs. of dry clover. We have here a convincing proof of the disadvantage of feeding off clover by sheep too early in spring. The loss in food was considerable, and the young clover on plot 1, as proved by analysis, was in no wise superior in feeding quality to that of plot 2.

4. The yield was at the rate of 1 ton 2 cwt. and 16 lbs. more fresh clover, or nearly 7 cwt. more clover-hay per acre than on plot 1.

The increase on plot 2 over 1 it will further be seen is entirely due to the much larger yield in the 1st mowing, for the succeeding mowings showed but little difference.

Looking at the composition of the fresh produce of plot 3 (see p. 48) it will be seen that the first mowing contained much more moisture than the three following, and that the 2nd mowing was unusually rich in dry matter. But comparing the composition of the dried clover it will be seen that the four mowings had a remarkably uniform chemical constitution, more especially as regards the percentage of nitrogen in each.

The chief points of interest, however, are noticeable in the 2nd and 3rd Tables, showing the actual weight of each mowing. Comparing the produce with that of the preceding plot, cut for the first time a fortnight earlier, it will be noticed that the first mowing on plot 3 actually produced 4 lbs. more fresh clover

PLOT III. TABLE I.—CLOVER EXPERIMENTS.

a. Composition of Fresh Produce.

	Date of Mowings. First, May 12.	Second, May 26.	Third, June 10.	Fourth, June 30.
Interval since former mowing ..	..	2 weeks	2 weeks	3 weeks
	lbs.	lbs.	lbs.	lbs.
Moisture	81·30	73·30	77·70	77·00
*Nitrogenous substances	2·87	4·12	3·56	3·56
Non-nitrogenous substances ..	14·24	19·39	16·04	16·76
Mineral matter (ash)	1·59	3·19	2·70	2·68
	100·00	100·00	100·00	100·00
* Containing nitrogen	·46	·66	·57	·57

b. Composition of Produce dried at 212° Fahr.

	First, May 12.	Second, May 26.	Third, June 10.	Fourth, June 30.
*Nitrogenous substances	15·37	15·44	15·94	15·44
Non-nitrogenous substances ..	76·13	72·62	71·96	72·9
Mineral matter (ash)	8·50	11·94	12·10	11·65
	100·00	100·00	100·00	100·00
* Containing nitrogen	2·46	2·47	2·55	2·47

TABLE II.—PRODUCE of Plot 3 in lbs.

	Date of Mowings. First, May 12.	Second, May 26.	Third, June 10.	Fourth, June 30.	Total.
Interval since former mowing	..	2 weeks	2 weeks	3 weeks	
	lbs.	lbs.	lbs.	lbs.	lbs.
Weight of fresh produce	98	4¼	11¼	8	121½
Weight of dry produce ..	18·32	1·17	2·50	1·84	23·83
Consisting of:—					
*Nitrogenous substances ..	2·81	·12	·37	·25	3·55
Non-nitrogenous matters	13·96	·92	1·83	1·38	18·09
Mineral substances (ash)	1·55	·13	·30	·21	2·19
* Containing nitrogen ..	·45	·02	·06	·04	·57

TABLE III.—Produce calculated per Acre in Plot 3.

Fresh produce in lbs. ..	15,680	686	1800	1280	19440 lbs. = 8 t. 13 c. 64 lbs.
Weight of dry produce in lbs.	2931·2	187·2	400·0	294·4	3812·8 lbs. = 1 t. 14 c. 8 lbs.
Produce calculated as hay (containing 16·7 per cent. of moisture) ..	3517·4	224·6	480·0	353·5	4575·3 lbs. = 2 t. 95 lbs.
*Nitrogenous matters ..	449·6	19·2	59·2	40·0	568 lbs. = 5 c. 8 lbs.
Non-nitrogenous substances	2233·6	147·2	292·8	220·8	2894·4 lbs. 1 t. 5 c. 94 lbs.
Mineral matters (ash) ..	248·0	20·8	48·0	33·6	350·4 lbs. = 3 c. 14 lbs.
* Containing nitrogen ..	72·0	3·2	9·6	6·4	91·2 lbs.

than all the mowings together on plot 2, or, in dry substance, almost exactly the same weight. The total yield of plot 3, calculated per acre, amounted to 8 tons 13 cwt. and 64 lbs. of fresh clover, which is 2 tons 2 cwt. and 96 lbs. more than the total produce per acre on plot 2.

Calculated as hay, plot 3 gave 2 tons and 95 lbs., whereas the yield on plot 2, which was mown a fortnight earlier, was only 1 ton 11 cwt. 45 lbs. Besides the loss in weight which takes place when clover is grazed early in spring, or mown too soon, the inferior character of the first mowings on plots 1 and 2 has to be taken into account. Weight for weight, therefore, the produce of plot 3 was more valuable than that of plots 1 and 2.

On comparing the weight of the clover reaped on plot 4 (pp. 50, 51) on the 26th of May with that of the two cuttings made on plot 3 on the 12th and 26th of May, we find a very large accumulation of organic matter has taken place by allowing the clover to grow a fortnight longer before mowing it. The fresh clover on plot 3, it will be seen, weighed 98 lbs. on the 12th of May, and $4\frac{1}{4}$ lbs. on the 26th of May, which is $102\frac{1}{4}$ lbs. together, whilst the first mowing on plot 4, made on the 26th of May, yielded 131 lbs. or $28\frac{3}{4}$ lbs. more. This increase in feeding materials is greater than the mere weights of the fresh produce indicate, for on looking at the composition of the first mowing of plot 3, it will be seen that the clover contained $81\frac{1}{3}$ per cent. of water, whilst the clover cut on plot 4, a fortnight later, contained only $78\frac{1}{10}$ per cent.; when due allowance is made for both these differences, it will be found that the single mowing produced nearly *one half more of solid food* than the double one.

During the fortnight which elapsed between the 12th and 26th of May, the clover appeared to come rapidly to perfection; it was then in full flower, and looked remarkably vigorous.

In this period the assimilation of carbon through the medium of the leaves or roots appears to be very great, for whilst sugar and other carbon-hydrates are at this time abundantly produced, little or no further accumulation of nitrogenous substances appears to take place. In the case before us the two mowings on plot 3 contained exactly as much nitrogen as the one mowing on plot 4. Calculated per acre we find in the clover of the 12th of May 72 lbs. of nitrogen, and in the second mowing on the 26th of May 3·2 lbs. of nitrogen, or 75·2 lbs. in all—the identical quantity of nitrogen which is contained in the much larger weight of clover obtained on plot 4, by cutting it only once on the 26th of May. At this stage of growth, as it seems, much carbon is assimilated by the plant for the production of sugar and other carbon-hydrates, which are serviceable in the animal

economy for the production of fat; whilst the nitrogenous substances previously taken up are diffused, and probably undergo greater elaboration. In both these respects the clover becomes much more nutritious and valuable at this time, in spite of its percentage in nitrogen being smaller.

Indeed, *within certain limits*, we may say that the amount of nitrogen in clover diminishes in the measure in which its nutritive value increases. We must, however, be careful how we apply this rule, for a small percentage of nitrogen may indicate alike the presence of much or of little sugar. In succulent, sweet-tasting, and really nutritious clover this percentage is small comparatively speaking, because the nitrogenous or albuminous compounds in the plant are diffused through a large mass of carbon-hydrates or fat-producers, and in overripe, woody, insipid, and innutritious clover the percentage of nitrogen also is small, because such clover contains little sugar and much indigestible woody fibre or cellulose, which is a non-nitrogenous substance.

The clover, on the 26th of May, as already mentioned, had just burst into full flower, and approached rapidly towards maturity.

PLOT IV. TABLE I.—CLOVER EXPERIMENTS.

a. Composition of Fresh Produce in lbs.

	DATE OF MOWINGS.		
	First, May 26.	Second, June 10.	Third, June 30.
Interval since former mowing	..	2 weeks	3 weeks
Composition of fresh produce:—	lbs.	lbs.	lbs.
Moisture	78·70	71·00	77·01
*Nitrogenous substances..	2·25	5·56	4·19
Non-nitrogenous matters	17·24	20·56	14·92
Mineral substances (ash)	1·81	2·88	3·88
	100·00	100·00	100·00
* Containing nitrogen..	·36	·89	·69
Composition of dry produce:—			
*Nitrogenous substances	10·56	19·18	18·18
Non-nitrogenous matters	80·94	71·09	65·01
Mineral substances (ash)	8·50	9·93	16·81
	100·00	100·00	100·00
* Containing nitrogen..	1·69	3·07	2·91

TABLE II.—WEIGHT of Produce in lbs. of Plot 4.

	DATE OF MOWINGS.			Total.
	First, May 26.	Second, June 10.	Third, June 30.	
Interval since former mowing	..	2 weeks	3 weeks	
	lbs.	lbs.	lbs.	lbs.
Weight of fresh produce	131	3½	14	148½
Weight of dry produce	27·90	1·01	3·22	32·13
Consisting of:—				
*Nitrogenous substances	2·94	·19	·56	3·69
Non-nitrogenous substances ..	22·52	·72	2·12	25·36
Mineral matter (ash)	2·44	·10	·54	3·08
* Containing nitrogen	·47	·03	·09	·59

TABLE III.—Produce, calculated per Acre, in lbs.

Fresh produce in lbs.	20960	560	2240	23,760 lbs. = 10 t. 12 c. 16 lbs.
Weight of dry produce	446·4	161·6	515·2	5140 lbs. = 2 t. 5 c. 100 lbs.
Produce calculated as hay (16·7 per cent. of moisture)	5356·8	193·9	618·3	6169 lbs. = 2 t. 15 c. 9 lbs.
*Nitrogenous substances	470·4	30·4	89·6	59·04 lbs. = 5 c. 30 lbs.
Non-nitrogenous matters	3603·2	115·2	339·2	4057 lbs. = 1 t. 16 c. 25 lbs.
Mineral substances (ash)	390·4	16·0	86·4	492·8 lbs. = 4 c. 44 lbs.
* Containing nitrogen	75·2	4·8	14·4	94 lbs.

Anxious to follow its fuller development with greater certainty, I determined to mow some of the remaining experimental plots from week to week during the month of July.

Plot 5 consequently was mown for the first time on the 2nd of June (or one week after plot 4), then subsequently a fortnight afterwards, and again six weeks later, with the following results:—(pp. 52, 53).

If we compare the composition of the produce of plot 4, mown on the 26th of May, with that of plot 5 mown on June 2nd, scarcely any differences will be seen. Both contain almost exactly the same amount of water, and both are also very equally rich in sugar and correspondingly poor in nitrogen. The results of my analysis from plot 5 satisfied me that the small percentage of nitrogen which I found in the produce of plot 4 (and of which I doubted the correctness until confirmed by repeated nitrogen-determinations) was not merely accidental; the two together afford positive evidence that at the period when clover bursts into flower the assimilation of nitrogenous constituents appears

to come to a standstill, whilst that of carbon-hydrates is proceeding with greatly accelerated speed.

Again it will be seen that plot 5 produced almost exactly the same weight of fresh and of dried clover which was yielded by plot 4, and thus it appeared that in the case before us a week's difference in the time of mowing had neither a beneficial nor an injurious effect.

The total produce of plot 5 is somewhat greater than that of plot 4; this is due, it will be seen, to the circumstance that the last mowing on plot 5 was made a month later than that on plot 4. Considering that quite a month was thus allowed for further growth, the additional produce is very trifling, but no doubt the dry state of the weather in July, and the somewhat baked state of the land, checked the further growth of the plant.

With the more matured condition of clover the percentage of water, it will be seen, fell considerably in the course of a single week; nevertheless the weight of the fresh produce on plot 6 was greater than that on plot 5, and on plot 7 (pp. 54, 55) greater than on plot 6. The variable proportions of moisture in fresh clover, however, introduce an element of confusion, wherefore it is better to compare the weight of the perfectly dry produce obtained from

PLOT V. TABLE I.—CLOVER EXPERIMENTS.

a. Composition of Fresh Produce in lbs.

	Date of Mowings.		
	First, June 2.	Second, June 16.	Third, July 28.
Interval since former mowing	..	2 weeks	6 weeks
	lbs.	lbs.	lbs.
Moisture	78·80	69·20	69·20
*Nitrogenous substances..	2·06	4·50	2·50
Non-nitrogenous matters	17·51	23·11	25·81
Mineral substances (ash)	1·63	3·19	2·49
	100·00	100·00	100·00
[illegible]ing n[illegible] ..	·33	·72	·40

b. Composition of Produce dried at 212° Fahr.

*Nitrogenous substances..	9·69	14·56	8·06
Non-nitrogenous matters	82·68	75·09	83·86
Mineral substances (ash)	7·68	10·35	8·08
	100·00	100·00	100·00
[illegible]ng nitrogen	1·55	2·33	1·29

TABLE II.—WEIGHT of Produce in lbs. of Plot 5.

	DATE OF MOWINGS.			Total.
	First, June 2.	Second, June 16.	Third, July 28.	
Interval since former mowing ..	..	2 weeks	6 weeks	
	lbs.	lbs.	lbs.	lbs.
Weight of fresh produce	132	1¾	18	151¾
Weight of dry produce (dried at 212° Fahr.)	27·98	·53	5·54	34·05
Consisting of:—				
*Nitrogenous substances	2·69	·06	·44	3·19
Non-nitrogenous substances ..	23·15	·42	4·66	28·23
Mineral matters (ash)	2·14	·05	·44	2·63
* Containing nitrogen	·43	·01	·07	·51

TABLE III.—Produce of Plot 5 calculated per Acre in lbs.

Fresh produce in lbs.	21,120·0	280·0	2880·0	24,280 lbs. = 10 t. 16 c. 88 lbs.
Weight of dry produce	4,476·8	84·8	886·4	5448 lbs. = 2 t. 8 c. 72 lbs.
Produce calculated as hay (16·7 per cent. moisture)	5,372·1	101·8	1063·6	6537 lbs. = 2 t. 18 c. 41 lbs.
*Nitrogenous substances	430·4	9·6	70·4	510·4 lbs. = 4 c. 62 lbs.
Non-nitrogenous matters	3,704·0	67·2	745·6	4516·8 lbs. = 2 t. 36 lbs.
Mineral substances (ash)	342·4	8·0	70·4	420·8 lbs. = 3 c. 84·8 lbs.
* Containing nitrogen	68·8	1·6	11·2	81·6 lbs.

from two mowings on plot 5, and with those from plots 6 and 7 at a single mowing.

The total quantity of dry matter grown on one pole of land weighed 28·51 lbs. when the clover was mown on the 2nd of June, and a second time on June 16th.

By allowing it to grow until the 9th of June 36·18 lbs. of dry substance was produced, and by giving it another week on the land, till the 16th of June, 39·36 lbs. of dry matter was obtained. These differences may not appear very great in themselves, yet they show that a single week's delay considerably affects the crop grown *per acre.* Between June 2nd and June 9th an increase of 1574 lbs. of solid feeding matter was obtained; between June 2nd and June 16th the difference was 2185 lbs., showing plainly the impolicy of beginning the clover-hay harvest too early in the season. Deducting from the total weight of

clover hay on plot 6 the quantity produced between the 9th and 30th of June—a quantity amounting to about $2\frac{1}{4}$ cwt.—an acre of clover yielded 3 tons and 2 cwts. of good hay, containing 16·7 per cent. of moisture.

On plot 7, where the crop was mown on the 16th of June, 3 tons $6\frac{1}{2}$ cwt. in round numbers of equally dry clover-hay was made. The further growth between the 16th of June and 28th of July was at the rate of exactly 1 ton of fresh clover, or about $7\frac{1}{2}$ cwts. of hay per acre. Altogether the yield of plot 7, estimated as hay, came to 3 tons 13 cwts. and 100 lbs., which, it must be admitted, is a very good crop.

Moreover, on plot 7 we have the largest accumulation of nitrogen. The nitrogen in the clover on the 16th of June here amounted to $113\frac{6}{10}$ lbs. calculated per acre—a larger quantity than was found at any of the other experimental mowings.

According to the preceding results, the week in which the 16th of June fell appears to have been the most profitable period for beginning the hay-harvest.

PLOTS VI. AND VII. TABLE I.—CLOVER EXPERIMENTS.

a. Composition of Fresh Produce in lbs.

	Plot 6. Date of Mowings.		Plot 7. Date of Mowings.	
	First, June 9.	Second, June 30.	First, June 16.	Second, July 28.
Interval since former mowing	..	3 weeks	..	6 weeks
	lbs.	lbs.	lbs.	lbs.
Moisture	73·20	70·90	74·10	69·50
*Nitrogenous substances	2·97	4·12	2·94	3·25
Non-nitrogenous compounds	21·80	21·83	21·08	24·38
Mineral matters (ash)	2·03	3·15	1·88	2·87
	100·00	100·00	100·00	100·00
* Containing nitrogen	·38	·66	·47	·52

b. Composition of Clover dried at 212° Fahr.

	First, June 9.	Second, June 30.	First, June 16.	Second, July 28.
*Nitrogenous substances	8·81	14·12	11·31	10·62
Non-nitrogenous substances..	83·62	75·06	81·44	79·97
Mineral matters (ash)	7·57	10·82	7·25	9·41
	100·00	100·00	100·00	100·00
* Containing nitrogen	1·41	2·26	1·81	1·70

TABLE II.—PLOTS 6 and 7 (Weight of Produce in lbs.).

	Plot 6. Date of Mowings. First, June 9.	Plot 6. Date of Mowings. Second, June 30.	Total.	Plot 7. Date of Mowings. First, June 16.	Plot 7. Date of Mowings. Second, July 28.	Total.
Interval since former mowing	..	3 wks.		..	6 wks.	
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Weight of fresh produce	135·0	4½	139½	152	14	166
Weight of dry produce (dried at 212° Fahr.)	36·18	1·30	37·48	39·36	4·27	43·63
Consisting of:—						
*Nitrogenous substances	3·19	·12	3·31	4·44	·44	4·88
Non-nitrogenous substances	30·26	1·04	31·30	32·07	3·43	25·50
Mineral matters (ash)	2·73	·14	2·87	2·85	·40	3·25
* Containing nitrogen ..	·51	·02	·53	·71	·07	·78

TABLE III.—Produce of Plots 6 and 7 calculated per Acre.

Fresh produce in lbs.	21,600	720	22,320 lbs. = 9 t. 19 c. 32 lbs.	24,320	2240	26,560 lbs. = 11 t. 17 c. 16 lbs.
Weight of dry produce	5,788·8	208	5996·8 lbs. = 2 t. 13 c. 60 lbs.	6,297·6	683·2	6980 lbs. = 3 t. 2 c. 36 lbs.
Produce calculated as hay (16·7 per cent. moisture)	6,946·5	249·6	7196·1 lb. = 3 t. 4 c. 28 lbs.	7,557·1	819·8	8376·9 lbs. = 3 t. 13 c. 100 lbs.
*Nitrogenous substances	510·4	19·2	529 lbs. = 4 c. 81 lbs.	710·4	70·4	780·8 lbs. = 6 c. 108·8 lbs.
Non-nitrogenous substances	4,841·6	166·4	5008 lbs. = 2 t. 4 c. 80 lbs.	5,131·2	548·8	5680 lbs. = 2 t. 10 c. 80 lbs.
Mineral matters (ash)	436·8	22·4	459 lbs. = 4 c. 10 lbs.	456·0	64·0	520 lbs. = 4 c. 72 lbs.
* Containing nitrogen ..	81·6	3·2	84·8 lbs.	113·6	11·2	124·8 lbs. = 1 c. 12·8 lbs.

On the remaining five experimental plots the clover was mown only once at the periods mentioned in the subjoined tabular statement of results:—(p. 56)

In the first Table, which gives the composition of the five mowings, we find, as might have been expected, that with the advancing season the clover became drier and drier.

On the 16th of June the clover on plot 7 contained 74 per cent. of moisture, a week later that on plot 8 contained only 72½ per cent., and a fortnight later only 65·2 per cent. In the week following the clover apparently gained a good deal of moisture, for on the 7th of July the percentage of moisture amounted to 68·7 per cent. This apparent increase, however, I believe was caused entirely by a heavy dew which lay on the clover when it was weighed in the field. At the next mowing we find only 64 per cent., and ten

PLOTS VIII. IX. X. XI. AND XII. TABLE I.—CLOVER EXPERIMENTS.

a. Composition of Fresh Produce in 100 parts.

	PLOT 8. Mown June 23.	PLOT 9. Mown June 30.	PLOT 10. Mown July 7.	PLOT 11. Mown July 18.	PLOT 12. Mown July 28.
	lbs.	lbs.	lbs.	lbs.	lbs.
Moisture	72·50	65·20	68·70	64·01	50·80
*Nitrogenous substances	2·56	2·87	2·50	2·37	3·00
Non-nitrogenous substances ..	22·81	29·49	26.59	31·01	43·27
Mineral matters (ash)	2·13	2·44	2·21	2·61	2·93
	100·00	100·00	100·00	100·00	100·00
* Containing nitrogen	·41	·46	·40	·38	·48

b. Composition of Produce dried at 212° Fahr.

	PLOT 8.	PLOT 9.	PLOT 10.	PLOT 11.	PLOT 12.
*Nitrogenous substances	9·31	8·25	7·94	6·62	6·06
Non-nitrogenous substances ..	82·95	84·74	85·00	86·13	87·99
Mineral matters (ash)	7·74	7·01	7·06	7·25	5·95
	100·00	100·00	100·00	100·00	100·00
* Containing nitrogen	1·49	1·32	1·27	1·06	·97

TABLE II.—PLOTS 8, 9, 10, 11 and 12, (Produce per Plot in lbs.).

	PLOT 8. Mown June 23.	PLOT 9. Mown June 30.	PLOT 10. Mown July 7.	PLOT 11. Mown July 18.	PLOT Mov July
	lbs.	lbs.	lbs.	lbs.	lbs
Weight of fresh produce	137	108	110	99	6
Weight of dried produce (dried at 212° Fahr.)	37·67	37·58	34·43	35·64	3
Consisting of:—					
*Nitrogenous substances	3·50	3·06	2·69	2·31	
Non-nitrogenous substances ..	31·26	31·89	29·32	30·75	2
Mineral matters (ash)	2·91	2·63	2·42	2·58	
* Containing nitrogen	·56	·49	·43	·37	

TABLE III.—Plots 8, 9, 10, 11 and 12, Produce in lbs., calculated per Acre.

Fresh produce	21,920	17,280	17,600	15,840	10,0
Weight of dry produce (dried at 212° Fahr.)	6,027·2	6,012·8	5,508·8	5,702·4	4,9
Produce calculated as hay (16·7 per cent. of moisture)	7,232·6	7,215·3	6,610·5	6,842·9	5,9
*Nitrogenous substances	560·0	489·6	430·4	369·6	2
Non-nitrogenous substances ..	5,001·6	5,102·4	4,691·2	4,920·0	4,3
Mineral matters (ash)	465·6	420·8	387·2	412·8	2
* Containing nitrogen	89·6	78·4	68·8	59·2	

ten days later, at the last mowing, only 51 per cent. of moisture in round numbers. It is hardly necessary for me to say that the clover on plots 11 and 12 was far more advanced in maturity than is likely often to be the case in actual practice, and that on all the five plots it was more or less overripe. My intention, in preserving these five additional plots for further experiments, was to ascertain to what extent and with what degree of rapidity clover loses in weight and in quality after it has arrived at perfection for feeding purposes.

It is interesting to notice the gradual diminution of the percentage of nitrogenous matters in the five last mowings. On the 16th of June we found 11·31, in the dry produce, on the 23rd only 9·31, in the week following 8·25; and this sinks to 7·94 in another week, and on the 18th of July we get only 6·62 per cent., and ten days afterwards 6·06 per cent. of nitrogenous matter in the dry clover-hay.

We have here a steady decrease of the percentage of nitrogen in the dry produce at each experimental period from the 16th of June to the 28th of July.

Thus the perfectly dried clover-hay contained—

	Per Cent. of Nitrogen.
On the 16th of June	1·81
„ 23rd „	1·49
„ 30th „	1·32
„ 7th of July	1·27
„ 18th „	1·06
„ 28th „	·97

This loss in nitrogenous matter appears to me to be chiefly due to the comparative small proportion of fine green leaves, and greater abundance of woody matter which is found in overripe clover-hay. At the same time I do not think the loss is entirely due to this cause, and the whole subject is well worthy a special investigation. It is extremely difficult to trace with precision the changes which nitrogenous matters undergo in the living plant, to determine their influence in the assimilation of atmospheric plant-food, or to account for their accumulation in plants at certain stages of their growth, and their diminution at others; though much patient scientific labour has been bestowed on the investigation of the loss of nitrogenous matter which takes place in the growth of agricultural crops, much more is still to be done before we can trace with certainty losses like those which take place, as Messrs. Lawes and Gilbert have shown, in the growth of wheat.

Looking at the Tables which give the weight of clover at the five last periods of mowing, we find less and less fresh clover at each succeeding period. Mown on June 16th, 1 pole thus produced 152 lbs. of fresh clover.

On June 23	.. ..	137 lbs.
„ 30	.. ..	108
July 7	.. ..	110
„ 18	.. ..	99
„ 28	.. ..	63

On the 7th of June apparently more clover was mown than in the preceding week. But if we look at the amount of dry substance in the clover on the 30th of June and on July 7th, we find $37\frac{1}{2}$ lbs. in the former, and $34\frac{1}{2}$ lbs. in round numbers in the latter.

The dry produce on the 18th of July was a little greater than on plot 11, mown eleven days previously. It must not be inferred from this that really more clover would have been obtained on the whole clover-field, if instead of mowing it on the 7th of July it had been allowed to grow until the 18th, for the whole tenor of the results of the experiments on plots 7, 8, 9, 10, 11, and 12 tends to show that the amount of dry clover decreased after the 16th of June from week to week. I am therefore disposed to conjecture that this exceptional result was due to the circumstance that the clover on plot 11 probably was a little thicker than on plot 10, or the land a little better.

On the last plot (12) the decrease in the weight of clover is very marked, as well as the deterioration in the quality of the produce.

The subjoined tabulated results afford additional proof to that already adduced, of the great deterioration of quality of clover which is allowed to become overripe in the field. The table gives the amount of soluble and insoluble matter, and as the amount of crude woody fibre (matters insoluble in water) indicates with tolerable accuracy the comparative amount of indigestible woody fibre in hay, the following results are not void of interest or partial utility:—

PROPORTION of Matters Soluble and Insoluble in Water in Clover-produce of Plots 5 to 12.

100 parts of Fresh Clover contained:

	Moisture.	Substances Soluble in Water.	Substances Insoluble in Water.
Plot 5 mown since June 2	78·80	8·70	12·50
,, 6 ,, 9	73·20	10·79	16·01
,, 7 ,, 16	74·10	10·00	15·90
,, 8 ,, 23	72·50	9·10	18·40
,, 9 ,, 30	65·20	13·60	21·20
,, 10 ,, July 7	68·70	10·90	20·40
,, 11 ,, 18	64·01	12·19	23·80
,, 12 ,, 28	50·80	14·40	34·80

100 parts of Dried Clover contained:

	Moisture.	Substances Soluble in Water.	Substances Insoluble in Water.
Plot 5 mown since June 2	..	41·04	58·96
,, 6 ,, 9	..	40·30	59·70
,, 7 ,, 16	..	38·61	61·39
,, 8 ,, 23	..	33·09	66·91
,, 9 ,, 30	..	39·08	60·92
,, 10 ,, July 7	..	34·83	65·17
,, 11 ,, 18	..	33·89	66·11
,, 12 ,, 28	..	29·27	70·73

In comparing the preceding results with each other, it must be borne in mind that the clover at the later periods of mowing contained very much less water than at the earlier stages of growth, and that therefore the comparison ought to be made on the dry clover dried at 212°.

There are one or two discrepancies in the results which I do not pretend to be able to explain; for instance, the clover on the plot which was mown on the 30th of June contained 61 per cent. of crude woody fibre, and the plot which was mown on the 23rd of June about 7 per cent. more. Having obtained the anomalous result, I am bound honestly to state the result, and must not attempt to make corrections or shape the scheme so as to agree well with the rest.

On the whole, however, it is clearly seen that by allowing clover-hay to get overripe it diminishes in quantity, and gets more woody and less nutritious the longer it is kept on the land.

Laboratory, 11, *Salisbury Square*, *Fleet Street*, *E.C.*
February, 1867.

III.—*Rinderpest Precautions and Remedies.*

SIR,—The following are the Cattle Plague notes, which were made, according to your request, in the course of my last summer's ramble among English herds. First, then, as regards precautions against the disease. As soon as it broke out in Sussex, Mr. Dumbrell, of Ditchling, who had upwards of a hundred Alderneys in milk, commenced washing them all over every morning with a weak solution of chloride of lime before they were put out to graze; the same disinfectant was kept standing in earthen vessels behind the stalls; the feeding-troughs and the drains were

also sluiced out with it daily; and every cow was tarred just above the nostrils. This herd was in a position of no ordinary danger, as three owners of adjacent land were losing beasts, and the infected farms were only separated from Mr. Dumbrell's by a hedge. A fourth herd was also suffering within a quarter of a mile. One of Mr. Dumbrell's shippons was bounded by the high road on one side and by a footpath on the other, but the cows were kept as private as possible, and no fat stock was brought on to the farm. These precautions were attended with complete success.

Major Gunter's Wetherby farm was in a deeply-infected parish, and cattle were dying or being slaughtered almost daily, close up to the park gates, for months. Chloride of lime was used liberally, but the Major's main reliance was on the very strictest observance of the isolation principle. The Duchesses and the rest of the cattle were divided into several lots of two each, and placed in small sheds all over the six hundred acre occupation; the yards attached to these sheds were netted round the bottom, so as to keep out dogs, hares, rabbits, and other "travellers." The herdsman and his assistants never went near any other cattle or person engaged about cattle on any pretence whatever; and if the Major had been out hunting, or anywhere else in the country, he never entered the sheds until he had changed his clothes. One valuable bull was slaughtered after a slight accident, rather than run the risk of bringing a veterinary surgeon to attend upon him; and when the butcher came for fat sheep they were driven out of the field for him while he waited with his dog on the road.

The Warlaby herd were in nearly as great peril, and had an equally happy escape. For six months the plague was within $1\frac{1}{2}$ miles of them, and nearly three hundred beasts went down either by disease or pole-axe. The last outbreak was within 400 yards of the farm-buildings, and the fate of this great herd seemed to tremble in the balance. Vaccination and Macdougall's disinfectant were freely used, but Mr. Thomas Booth's main reliance was on burning tar in braziers at several points of the farm-yard. These fires were carefully looked to the last thing at night and the very first thing in the morning, and might have been smelt down wind for a couple of miles. So much for successful preventives—*quantum valeant.*

Secondly, as to remedies. In the case of Mr. Davies, of Mere Old Hall, near Knutsford, preventive measures failed, simply, as he believes, because, when the grass came, he placed his cattle in the field for a short time daily, out of the influence of chlorine gas. In this belief he is confirmed by the experience of his near neighbour Lord Egerton of Tatton, whose milch cows and feeding

stock were subjected to the same treatment, but never allowed to leave the shippons. Hence, in spite of a severe attack of the plague on several farms in the vicinity of the Tatton Home Farm, they all escaped, while some of the West Highland bullocks in the park went down. Chlorine gas was quite the fashion in Cheshire, and as farmers were very "jealous" of contagion, every rural policeman carried, at the suggestion of Professor Stone, a wooden kit with him, as well as a waterproof bag, for disinfecting his dress. The kit had four compartments for bottles of muriatic acid, chlorate of potash, Stockholm tar, and "soap and sundries." The two former generate chlorine gas by contact, and a few drops of the tar poured upon some hot cinders will disinfect boots or clogs when suspended on a poker within reach of its vapour. The inspection dress is made of strong calico and fashioned like a diver's, and it is fumigated and made ready for the next visit by putting it into the bag along with a perforated box in which chlorine gas has been generated and retained on pumice stone.

Mr. Davies' shippon is at the junction of three roads leading to Chester, Warrington, and Knutsford, and in the centre of a district through which the plague wended the same fatal way that it did in the last century—commencing near Warrington and coming along the low ground. In the small township of Tabley alone 662 beasts died; 41 were slaughtered, and only 20 per cent. were left. It skipped some farms and attacked others, and it would sometimes in its later stages take one cow and return to the same herd for another victim at the lapse of three weeks. Cleanliness was of no avail, and some of the very worst kept shippons escaped. Mr. Davies's precautionary efforts were unintermitting from the first. Every beast about the place was vaccinated; hyposulphite of soda, beginning at 3 lbs. and so on to 5 lbs., was mixed for four or five months in 100 gallons of water; and chlorine gas was used night and day in the shippon. Sawdust was substituted for straw, in consequence of its absorbing the *fæces* better, and being so much more easily removed. The cattle were never more blooming than when they were turned out in the middle of May, for a few hours daily, into a field adjoining the shippon and abutting on the high road. There was no infected farm nearer than a mile, but at the end of three weeks an Alderney heifer was taken ill and died in 36 hours. She had no symptom of illness about her except a slight discharge from the vagina, and until the veterinary surgeon opened her, he thought she was ruptured. The bull by which she had been recently served was slaughtered immediately, but there was no arresting the evil, and in two days more nine or ten were down with it. Leonora, from Mr. Jolly's, was the first decided case,

as they found her one morning with her back up, her coat staring, and her head and ears drooping; but Lady Best from the late Mr. Langston's, Minstrel from Holker, Heiress from Mr. Hales's, Cherry Empress from Mr. Logan's, and Water Girl from the late Mr. Anthony Maynard's, soon followed suit. They sickened for three or four days, and on the fourth there was a strong discharge from the nose, eyes, and vagina. They could neither lie nor stand; their legs and heads were never still, and their moanings were sad to hear. They would become feverish, and then shiver like a man in the ague, and their *fœces* were quite lax and costive by turns.

As they were very valuable stock, and Cheshire was at its wit's-end in the hope of discovering some alleviation or remedy, the local committee consented to have them treated, but everything was useless except the iodine ointment, a compound of iodine, mercury, and lard, which was recommended by Mr. Lawson, veterinary surgeon of Manchester. His object was to set up a counter-irritation if possible, and the ointment rubbed twice or thrice a day on the chest gave apparent relief. When applied in the early stage it seemed their only chance, but unfortunately it was not thought of till some of the best had died. The climax was generally on the fourth day, and those which died often lingered on about three days more. One old cow of the Towneley blood fought on for upwards of a fortnight. When the turn for the better came, frequent doses of oatmeal-gruel were administered. Up to that point they could not be got to take anything, as their mouths were sore with inflammation, and they did not even notice water. Countess of Barrington and Surmise were never so ill as the others, but they wasted to skin and bone, and it took them and seven others (which had all been treated with iodine ointment) several weeks to recover their bloom. None of these nine survivors out of thirty-six were able to carry their calves, but slunk them, a perfect mass of putridity, after which they "came to hand" much quicker.

Mr. Aylmer, of West Dereham, grounded his treatment entirely on the administration of chloroform. When the plague broke out on this gentleman's farm last April, sixteen store bullocks were immediately slaughtered; and of his shorthorn herd, which numbered ninety head, five died before treatment, and six were not attacked; while forty-one recovered, and thirty-eight died under chloroform treatment. On April 4th the disease showed itself by simultaneously attacking Easthorpe Rose in the home shippon, and then Easthorpe Lady in the fen (which is 1½ miles distant); and, on the 11th, Henrietta was taken ill at the White House Farm, within 300 yards of Mr. Aylmer's residence. The herd, which its owner always regrets having turned into the

fields so early, was, like Mr. Davies's, of far too much value to be given up to the pole-axe without an effort, and hence, by the advice of Mr. Anthony Hamond, and with the ultimate sanction of the Privy Council and the assistance of Mr. Robert Overman, of Egmere, who had cured six by that agency already, Mr. Aylmer determined to try chloroform. "A friend in need is a friend indeed," and with very occasional absences, Mr. Overman worked day and night at West Dereham for nearly two months. They commenced on the 12th, when five had gone down, and a staff of seventeen or eighteen men were soon in regular hospital work.

The cattle were kept as warm as possible, and covered with sheets in their sheds—which were made still more snug by hanging curtains of sailcloth or sacking in front of them—and the disease was always allowed to develope itself in the mouth before the treatment began. They were also kept on as short commons as possible, and their mouths were examined the moment their appetites failed. Still there was no exact rule in the matter. Some were heavily smitten and full of mouth-symptoms when the appetite was good and the dew was on the nose. The fat cows were uniformly the worst cases; and the one ear down, the drooping eyelid, and the nervous twitch of the head, were among the sure and certain symptoms of seizure. Some became quite mad with pain, and broke their horns and tore out their teeth with convulsive rushes at the manger; whenever the air lodged in the tissues, and the skin was swollen up some inches from the flesh, nothing could bring them round.

It was found in practice that the chloroform acted best on an empty stomach, and that it could be applied too soon after the premonitory symptoms. A white steer, among others, which inhaled for seven days, and relapsed at the end of a fortnight, was certainly dealt with too soon. In fact, looking back upon the cases, both Mr. Aylmer and Mr. Overman believe, that with their present experience, they could have saved many more with half the quantity of chloroform. The bulls were as easy to chloroform as the cows, and they were one and all cast and bound to prevent them breaking their horns. With some young bulls the chloroform acted too severely on the kidneys, and fatal inflammation of the bladder and urinary canal set in. After this, diuretics and alkaline solutions were used to neutralise the salts of the urine, and in two or three cases it had the desired effect.

Full-grown beasts had an ounce of chloroform administered to them each time, calves a quarter of an ounce, and others in proportion to their age. A saturated handkerchief was simply put in a bag, which was hung close under the nostrils, and tied by

a string behind the poll. Five to seven minutes was generally sufficient to produce insensibility, and the cattle were kept under the influence for periods of from half-an-hour to two hours. Seven or eight doses upon the average were generally found sufficient to effect a cure. Rosa Lee had seventy-four inhalations between April 19th and June 18th, and five others had from forty-eight to sixty. General Hopewell, which was hired from Mr. Thomas Booth at 200 gs. for the season, was a very anxious and curious case, as his general external symptoms were healthy but his mouth very bad. He was only ill three days, and had six inhalations, but his cure became hopeless, and he was killed on the fourth. Master Jolly fought hard for a month, but fifty-two inhalations only kept the disease under, and failed to cure him.

The leading effect of the chloroform was to convert the breath of the cattle from a very foul into a perfectly pure state. Before the administration the stench from their fevered mouths was fearful, and in a few minutes the breath became "as sweet as a nut." The inflammation of the mouth also seemed very much subdued, and the blood-shot fiery eye, under its influence, gradually grew quite natural again. It appears to neutralise the poison in the system, while the suspended vitality gives the constitution rest and enables it to "spar for time." The fever usually returned in not less than twelve hours, and if it kept away for more than forty-eight they were generally safe, and ready for linseed tea, oatmeal gruel, and other stimulants. Still the disease was most treacherous. They would rise up, eat hay, and drink water after chloroform as if nothing had happened, and then, when everything seemed going on well, they would relapse and become as ill as ever. However, after all this care and anxiety, Mr. Aylmer found himself, before July, with a clean bill of health, and with upwards of 50 per cent. of those which had been treated, alive and well in their stalls. All of those which were in calf went their full time, and the calves showed no traces of the crisis through which the dams had passed. The treatment was originally suggested by Dr. Dickson, author of 'The Fallacies of the Faculty.' Such are the principal facts as to precautions and remedies which I gathered in the course of my tour, and I leave them without comment in your hands.

Yours, &c.,

Henry H. Dixon.

P. Frere, Esq.

IV.—*Rainfall, Water Supply, and Storage.* By Prof. Ansted.

Part II.*

II.—Natural Surface-Drainage.

Of the water falling on the earth as rain part will before long be re-evaporated into the atmosphere, while part will run off in streams, and so ultimately enter the earth, and there be lost sight of, at least for a time. Since the history of the portion evaporated belongs rather to meteorology than to our present inquiry, it is enough to remark here that the proportion evaporated, though differing in different places, is generally at least 14 inches. It depends partly on the form of the ground, partly on the absorbent or non-absorbent character of the rock, and partly on the general climate of the country, but chiefly on the actual state of the atmosphere. With these observations, we may now endeavour to trace nature's provision for the circulation of water on the earth's surface.

Almost all definite natural divisions of the land consist of a surface, partly mountainous or hilly, partly of plains lying between these elevated tracts, at some height above the sea, and partly of low flats near the sea-level. Each of these affects the natural drainage, and beyond a doubt, the principal details, if not the grand features of the land, are due to the action of water that has fallen on the surface as rain.

In any country on the higher ground, and among the mountains if they exist, the rainfall will be heaviest, and the course of the rain down the steep slopes will be most rapid. The collected waters will form the head-waters of the principal streams. Thus, in England, the sources of some of the largest and most rapid rivers are to be found in the mountains of Wales. But in all countries it is chiefly to the hills and lower undulations that we must look for the minute history of the surface-drainage, and the position of the hills governs in effect the drainage of the country. In our own country the higher hills and mountains are on the western side of the island, and we have already seen that the rainfall is heaviest there. It is also an important fact that in England the gentle slopes of the hills, and the longer distances from the hill tops to the sea, are everywhere rather to the east and south than to the west and north. This is favourable to the production of streams large in proportion to the area of the land.

Thus the natural drainage is clearly defined. The water leaps down the mountain sides, and it runs briskly and rapidly

* Continued from vol. ii., p. 79.

down the steep slopes of the valleys, but as it gets lower and meets other streams, and at length attains a more definite character, it becomes a deeper and steadier body, and moves with a more regulated pace until it reaches the lower plains. It then advances more slowly, and is more easily turned aside by impediments. It assumes a serpentine course, winding in and out, and depositing from time to time part of the load of mud, sand, and stone that has been brought into it by its numerous tributaries. Throughout its course it appears to follow exactly the undulations of the ground, but a careful search will show that this course is really governed by the geological structure of the country, and by the hardness or softness of rocks which are now out of sight, and covered with a great thickness of transported material.

A knowledge of the laws that govern the natural surface-drainage of a country is very essential to the agriculturist in laying out a system of drainage that shall fall in with and not oppose nature. In some parts of England, as in the upper part of the valley of the Thames, the lower part of the valley of the Severn, the middle and lower parts of the Trent valley, and many of the streams in Lancashire and Yorkshire, the natural surface drainage is especially instructive and exhibits clear proof of the effect of weather, and the eroding action of running water. Some of the streams that run into the sea on the east coast, between the Norfolk coast and the Humber, exhibit remarkably well the results produced when water runs over perfectly level tracts. Many of our rivers have changed their channels considerably within the historic period.

That proportion of the whole rainfall of a district that is carried by the streams to the sea must vary extremely. It varies, however, according to certain natural conditions, and admits of modification by the results of human labour and cultivation. It is calculable in a limited district, and various estimates concerning it, more or less accurate, have been made in our own country and elsewhere. Thus in the west of Lancashire, with a somewhat heavy rainfall amounting to about 34½ inches, and in a limited area of hard non-absorbent sandstone rock, with very little vegetation, as much as 26 inches, or fully three-fourths of the total rainfall, has been collected into a reservoir placed to intercept and bring together all the natural channels of escape. This is the result of observations ranging over several years, and taken with great care, but it is no doubt an extreme example of maximum drainage.

In the case of river systems, where the whole of the land which would naturally fall towards the affluents of a river down to a certain point, is assumed as the drainage area, the pro-

portion is far smaller. Thus the river Severn drains 3890 square statute miles of mountain, hilly, and plain country, before it passes Gloucester. At that point of its progress about twenty-three parts in a hundred, or rather less than one-fourth of the whole rainfall, passes down in the year. The river Thames at Staines has drained 3086 square statute miles of hill and plain, and wide valleys, and there discharges about thirty-three parts in a hundred, or one-third of the rainfall of the district. The river Seine was long ago estimated by Arago to carry off about one-third of the rainfall, and as the country it drains is not unlike that of the Thames drainage area, the correspondence is striking and satisfactory. In all these cases the country is partly under cultivation, but much more so in the valley of the Thames and Seine than in that of the Severn. In other countries similar results have been obtained. Thus the Saône, a rapid stream draining much mountain and uncultivated land far from the sea, and joining the Rhone, discharges into that river nearly three-fifths of the estimated total rainfall of the drainage area, while the Tiber is believed to carry off as much as seven-tenths. The calculations however, with regard to these rivers, are of doubtful accuracy. In the case of the great river Mississippi and its numerous large feeders, it is believed, from tolerably certain data, that only one-fourth part of the total rainfall of the drainage area reaches the gulf of Mexico. Thus in a general way we may consider that from one-fourth to one-third part of the rain that falls runs along over the surface to the ocean.

The result of human labour and cultivation on the natural drainage of a country is in all cases to increase the quantity of water carried off, and to carry off the water more quickly. By the clearing away of forest, and by all kinds of artificial drainage, both these results are obtained; and such works, though they may at first seem simple agricultural improvements, have a marked influence on the climate and physical features of the country operated upon. When Fens, like those of the East of England or Holland, are laid dry by lifting the water, when straight cuts are made to relieve tortuous watercourses, when by deep drainage we actually bring back to the surface water that was already on its way into the rocks, the quantity of water that reaches the sea is increased, and this extra quantity is abstracted from that which would otherwise have entered the earth and circulated through it. There are no data by which we can judge of the exact difference, but in proportion as a district becomes drained it is certain that all the causes alluded to must act with increasing intensity, and may ultimately seriously interfere with the subterranean storage. Let us then, in the next place, consider this subject of storage a little more in detail.

III.—SUBTERRANEAN WATER-STORAGE.

That part of the rainfall which enters the earth, serves to supply and renew the natural and artificial springs, modify the condition of strata, and to promote, or by its excess to injure, vegetation.

The proportion of rainfall which enters the earth will depend not only on the nature of the soil and rock, the form of the ground, and the total rainfall, but on the mode in which rain falls. Where it falls in very heavy showers, there will be a large proportion carried off along the surface. Where rain is light and frequent, although the fall may be represented by a smaller number of inches, a larger quantity will soak into the strata. But although this is a general rule, it must also be remembered that during long droughts the earth becomes cracked, and that the cracks in time may become deep and then wide, and capable of receiving an enormous proportion of the first rains that fall. I have myself seen in the south of Spain marly sandstones, otherwise not very permeable, cracked so widely and deeply that they offered great impediments in getting across the country. Clays also are not unusually cracked in some parts of England to a depth of six or eight feet, or more, in an ordinary summer; and in hot countries gorges are thus formed many yards deep, and so wide that a horse can hardly be got across them. It is at any rate evident that in all places, and under all circumstances, a large and important part of the rainfall must sometimes enter the earth. It is also clear that, when there, it has no means of escape, except by subterranean channels or by filtration through the solid rock. But such filtration is not difficult. The peculiarly broken and cracked condition of hard limestones and other brittle rocks renders them capable of receiving very large quantities of water, while all the softer limestones are eminently porous and absorbent even in their solid mass. Hard rocks are always fissured, and often cavernous. Limestones abound with extensive open spaces, and in some cases these contain lakes; in others large rivers run through them. The great caverns of Adelsberg in Carinthia, and Kentucky in North America, are examples of this; and many others nearer home, on a smaller scale, as in Derbyshire, Yorkshire, Somersetshire, and South Wales, will suggest themselves to every reader. But sandstones of the harder kind are also fissured; and granites invariably abound with joints, leading occasionally to open spaces, so that water can be reached and obtained from them by the ordinary operations of well-sinking. Mining developes very clearly the peculiarities of all these rocks, and exhibits

them broken and cracked, and allowing water either to pass through them out of sight, or collect into pools and open spaces in the interior of the earth.

It cannot be necessary to point out that the effect of a thorough system of artificial drainage in a large district must be to carry the rainfall beneath the surface both more rapidly and more completely than would be the case otherwise—more rapidly because it is conveyed at once into straight watercourses, avoiding friction, and shortening distances; and more completely because there is time allowed for considerable quantities to penetrate far down in places where the natural absorbing surfaces of rock would act slowly. This is especially the case where the surface of a rock is covered by a thick coating of vegetable soil, because it must then be very liable to become choked.

It requires only a very superficial examination of rocks to discover how fit they are to absorb water, and how it is that they have become so fit.* All rocks, without exception, that have been long exposed to the air have become weathered, and a part of this weathering consists in the production of innumerable cracks on the exposed surface. In very hard rocks these are often dependent on the presence of particular minerals or of veins of foreign material; but in the hardest granite there is always some way in which moisture can enter, and once there its alternate expansion and contraction due to changing temperature, especially near the point of greatest density of water (about 39° F.), is sure to destroy the texture very rapidly. A few examples of the observed influence of weather on rocks of different kinds may be useful. I will give only some results of personal investigation in various parts of the world.

Of all rocks it might be supposed that the granites were those most able to resist weathering; and no doubt some varieties do resist atmospheric action to a very great extent; but all rocks of this kind consist of alternate veins of harder and softer material. Of some the harder is the largest in quantity. Such rocks are valuable for building, and are little affected by weather; but even in such hard granites there is always a certain amount of change produced in time — the surface becomes rough, some of the crystals are decomposed, and plants find room for their small rootlets in the crevices thus formed. Many of the softer varieties show the results of weather much more clearly. In a quarry one may often find that the recently cut face of the stone is discoloured to a depth

* It must be remembered that all rocks within the earth were originally deposited with, and under water, and have never since been deprived of this water completely. Throughout all changes that may have taken place in their composition water has always been present.

of some feet or even yards. Wherever this discoloration has taken place, the rock is softer and contains more moisture, and the surface is full of crevices: here the work of destruction has begun. In the Channel Islands, remarkable for their excellent granite, there may be seen at least twenty feet of the stone on which part of the town of St. Peter Port, Guernsey, is built reduced to such a state that it can be dug out with a spade. In Jersey, behind St. Aubin's, there is a thickness of at least thirty feet of a kind of gravel, which is nothing more than the loosened crystals of the felspar and quartz of the granite decomposed by weathering, and quite disintegrated. Close by, the same rock juts out in isolated masses into the sea. In Alderney the centre of the island contains innumerable round boulders of granite entirely the result of decomposition; and yet from these islands are obtained some of the hardest, toughest, and most enduring granites in common use. So again I remember seeing among the grand basaltic columns of the Giant's Causeway, in the North of Ireland, the roots of plants twined round the slices of six-sided columns ten or fifteen feet below any point exposed to the air. The rock itself seems indestructible, but the traces of decay are evident on close investigation. These are but a few instances out of many in which I have seen crystalline rock affected by weather to a great depth without any other cause than the penetration of moisture by absorption. I may safely say that I have never in any part of the world seen a natural or artificial face of granite or basalt exposed without finding evidence of the destroying power of weather, acting always by aid of water penetrating within the mass. Besides destruction of this kind, the joints of granite frequently contain water, and sometimes yield it in large quantity from artesian wells.

Sandstones of all kinds exhibit weathering, and water penetrates them to great depths. The softer varieties of sandstone are easily cracked during even a short continuance of dry weather. When rain comes it fills these fissures, and penetrates yet more deeply. All sandstones are more or less porous, and in this way admit moisture. All are more or less distinctly bedded, and they generally allow water to pass along in the intervals between the beds. All, again, are more or less cracked and fissured at the surface. The chemical effect of water in dissolving and decomposing is less seen in sandstones than in granites, except when the sandstone is impure, and contains marl, calcareous cement, or a mixture of mica and felspar. In such cases the result is soon seen, and is often very great. On the whole, there are no rocks that admit water so slowly as pure crystalline sandstones and quartzite and none that are more absorbent than soft, loose, rotten sands with which marl is intermixed.

The facility with which sandstones absorb water is illustrated by the quantity of water they contain both in their ordinary state and when saturated. Even granite always contains a certain percentage of water, and in the dry state is rarely without one and a half pint in every cubic foot. Sandstones, however—even those fit for building purposes—may contain half a gallon per cubic foot, and loose sands at least two gallons. When the water is present in any part of a rock, it readily diffuses itself owing to the force of capillary attraction; but although the diffusion is rapid from a moist to a dry part of any rock, however close its texture, the rate at which a fluid collects in cavities from a stone not absolutely surcharged is extremely slow. This is especially the case with sandstones.

Limestones contain very large quantities of water, not only in cavities underground, but in crevices of the rock, in spaces between strata, and in faults. Dry compact limestones contain half a gallon of water in every cubic foot. Bath stone contains at least a gallon, and some magnesian limestones one and a half gallon. Chalk is as absorbent as loose sand, and contains at least two gallons per cube foot when saturated.

It is not easy to realise the magnitude of these quantities, although the results have been determined very accurately by calculation and experiment. If we limit our estimate to an area of the chalk downs 50 miles in length, 10 miles wide, and 300 feet thick, we shall find that the total annual rainfall on the surface (taken at 30 inches per annum) will amount to 225,750,000 gallons; while the water contents of the rock, if only half saturated, would be more than 660,000,000 gallons, or nearly three years' total rainfall, and fully twelve years' average supply even if there were no loss by evaporation, and no circulation underground. It must be evident then that there is an unlimited power of absorption in such rocks; and as water is distributed through them rapidly and thoroughly, they may be regarded as large receptacles partly filled, but in which the water is constantly in circulation, rising and falling according to the influence of past and present weather. The longest succession of the driest seasons can never exhaust them: the heaviest rains repeated for years can never fill them. Other absorbent rocks exhibit the same general features in a different degree, and all assist in the general circulation, the water-level rising after rain, and sinking by evaporation during drought, so as never to leave the surface either absolutely wet or perfectly dry.

And this is the case not only with chalk, which is itself absorbent in the strict sense of the word, but with hard, brittle limestones, that seem to admit water only by the cracks and fissures at their surface. I have noticed in the Ionian Islands

remarkable instances of this. On the steep flanks of a lofty mountain, in the middle of Cephalonia, there is an accumulation of loose, angular fragments of limestone rock standing at the natural angle. On this heap there neither is nor can be an atom of soil. The rain when it falls is very heavy, and would carry down to the bottom any loose particles that might be conveyed thither by man or formed by nature: the rain itself also must sink at once to the bottom. On this heap of bare stones the vine not only grows but flourishes, and the grape ripens admirably. The rootlets twine round the stones, and they manage to extract from them and from the air all the nourishment they require. I have often seen crops on stony ground, but nowhere so marked an instance as this of the resources that exist in solid naked rock under favourable circumstances.

It is only clays and similar tenacious rocks that do not freely admit of the passage of water. Even these admit it slowly and imperfectly, and they always contain moisture. The amount of the water contents varies according to weather, and the water is here also in circulation, though slowly. These tenacious rocks, however, greatly assist in the distribution and circulation of water in the earth in another way. Passing freely where the soil is open, water is checked in its course where the rock becomes compact and impermeable. As these alternations occur sometimes in parallel and horizontal strata or layers, sometimes in strata inclined to the horizon, sometimes in vertical or nearly vertical planes, there is every possible variety of direction in the course taken by the water. This is a matter that cannot be even guessed at without a knowledge of the geology of the district. With clays we must rank all such tenacious rocks as act in a similar manner, and shut off communication. Thus, various shales, slates, and marls are impermeable; while others, even if partially permeable, act as impermeable rocks, and divert the course of underground waters. The former rank as clays, and the latter as grits or limestones, according as the sandy or calcareous element preponderates.

It is not only by their nature, composition, and texture that rocks and certain strata shut off water; in many countries the rocks have been broken while being upheaved by mechanical pressure from below; and when broken, part of a stratum has often been lifted up so as to occupy a position altogether different from the rest. An absorbent rock may thus, by displacement, be made to abut against a non-absorbent rock. A crack may be opened in a series of rocks down which water may be conveyed, or up which it may rise, according to the condition of adjacent rocks. Communication may also be thus made with the interior of the earth, and with places where some chemical

action is going on, where water is heated or converted into steam, and whence jets of mineralized water may be forced upwards. Such conditions modify and complicate the phenomena, but they do not affect the general explanation. The disturbances that have resulted only in the tilting or partial lifting up of strata act in one way, and those disturbances that have broken and displaced them act in another, so far as water is concerned, but both help in the distribution and circulation of the water through the earth. So, again, the filling up of fissures caused by disturbances may entirely shut off whole districts from the passage of water, and cause the water to collect in certain strata to an unusual extent. This is a fact very familiar to all who have had to do with coal mining, where *faults* (as these disruptions of strata are called) are very common and systematic, and where very serious accidents have happened from breaking through them when they shut off water from surrounding strata. On the other hand, they as frequently carry off as hold back water; and in the broken coal-fields of England and Belgium they always play a very important part in the underground drainage.

Those fractures of rock, that are technically called axes (anticlinal or synclinal), also affect the underground passage of water. Their action may best be studied in the natural sections presented in cliffs or railway cuttings. Such sections show the strata dipping away from or towards each other, and meeting at an angle. It is evident that if of such strata some are permeable and others impermeable, the water passing through the former will have a tendency to escape at the angle made by the rocks that have been thus broken while being lifted up. Practically, then, the effect of faults and axes will be to carry the water down to the permanent level of absolute saturation, and assist in this way in its general progress through the interior of the earth.

Water thus passing into rocks from above, and passing also amongst them, cannot but be regarded as "circulating" in the earth's interior. Of such circulation evidence is offered by every natural and artificial spring, whether issuing from a hill side or rising from an artesian boring in a valley, and by the condition of rocks seen in quarries or reached in mines. It is owing to the presence of water in and amongst rocks, and in the fissures that are formed in them during and after elevation, that their various metamorphoses or changes of appearance can be produced. Pressure, together with the chemical action arising from heat, no doubt affects strata; but the changes that have taken place involve not only the mechanical presence, but the chemical action of water, dissolving away many substances as it passes through a rock, and leaving behind many others. Even

when no change of mineral species is effected, there is frequently an atomic change in rocks, such as is shown in the rearrangement of the particles from mechanical aggregation to crystalline texture. For this water is necessary. The soft clay, moulded on some organic body—a cockle-shell or the fragment of a bone in an altered state—is thus found to afford important evidence of the condition of the earth's interior, and the movements that have taken place there.

But it may be desirable to explain a little more fully the law of nature in reference to springs of water. The ordinary arrangement of rocks is that of stratification. They have been originally deposited horizontally with and from water, but they have since undergone great change. The water in fact has been partially got rid of, and the mud consolidated. They have also been thrust up from being below the sea to a position sometimes many thousands of feet above that level, and in the elevation some portions have been broken, and very large quantities have been pared away by water action. Thus limestones have become cavernous, sandstones are full of crevices, and the whole mass has been shut off into boxes, having very slow communication one with another. Thus, also, water entering a second time and from above, sinks down, penetrating every crevice, occupying every cavity, carried on from one box to another, or filling one before passing on to the next, running down hill whenever the strata admit it, often forced up hill when there is pressure behind and there are no other means of escape; and, in a word, circulating among and through the strata, and the faults and joints produced in them, and while simply obeying its own laws, conveying the means of chemical change from one part of the earth to every other part, and from the surface to the greatest depth to which strata reach. In all strata there is at some depth, great or small, a surface of absolute saturation. If this surface be reached by a well or boring, or if it be intersected by a natural cliff or hillside, or by an artificial cutting, the water will escape, or can be brought to the surface by pumping. To this depth the rock will always absorb. Below it water will be yielded up. But it may, and often does happen, that long before reaching the depth below which the whole rock is saturated, there are extensive sheets of water kept back by impermeable strata. These also, when reached or intersected, yield water, but if penetrated, the water would pass downwards to the rocks below, and the wet rock become drained. There are thus surfaces of partial saturation. By sinking to or below these surfaces extensive an[illegible] mportant results have been effected, both in well-sinking an[illegible] [illegible]ainage.

[illegible] hat [illegible] very different conditions of the water

are conceivable. It might remain at rest beneath the partial or absolute surface of saturation, having found its natural level, exposed to reduction only from evaporation taking place in the rock above it: it would then be in the condition of water in a tank. But it might circulate between two impermeable strata, and run between them from one point underground to another, and in this case it must act as if confined in a tube. In the former case, the strata above can never be absolutely dry, because if there be any water whatever in an absorbent rock, a part at least is distributed through the mass. This I have myself proved by actual experiment in the case of chalk.* It is also clearly indicated by the vegetable growth that takes place on the surface of limestone, apparently quite dry during the whole of a perfectly rainless summer in hot countries. This also is a fact within my own personal experience. Whenever water is present in a rock, it is distributed through it, but there is more below than above. The distribution takes place by capillary action, and cannot be checked, but the reservoir is in the lower part of the rock. If then into such rock or rocks so situated, having even at great depth a surface of absolute saturation, we penetrate to such surface, we shall certainly reach water. This is the case of *land springs*, commonly so called. It differs mechanically from the case of *Artesian springs.*

Although water percolates with a certain amount of freedom through rocks of all kinds, there must always be a great deal of friction in the operation, so that time is needed to effect the distribution, even under the most favourable circumstances. Thus, in the case of land springs of the ordinary kind in sands and gravels, the effect of a single shower may perhaps be recognised within four-and-twenty hours. Where the gathering ground is larger, and the deposit thicker, a wet season may actually leave the springs lower than before, while a subsequent dry season may be followed or accompanied by an unusual flow of water. This must happen when the position of the surface of saturation is so far removed from immediate influence as to need months or a year or two to convey the water from the surface of the ground.

But if absorbent or loose strata act as tubes or pipes, the water contained in them will be forced on by a pressure corresponding to that of a vertical column of water, equal in height to the depth from the surface of permanent wetness, or that at which the impermeable beds are entered, and where, therefore, the pipe condition begins. It will not be equal or nearly equal to the full calculated result of such pressure, because of the friction, which greatly diminishes the force, but still the pressure

* See Excerpt 'Minutes of Transactions of Soc. of Civil Engineers.'

may be sufficient to lift the water towards or above the actual surface from which it is pierced, or at which it is intersected, provided the level of such surface is sufficiently below that of the gathering ground.

The wells bored through various rocks to reach absorbent and saturated strata at some depth lying between impermeable strata of any kind, are well known under the name *Artesian*, having been introduced into Europe during the middle ages in the province of Artois, in the north of France. Similar wells have, however, been known, and sunk from time immemorial in various parts of the East, and in the desert of Africa. It would at once be admitted that water is constantly in circulation if, wherever we sunk through permeable beds, we always found a surface below which everything was saturated—and if, whenever we penetrated impermeable beds, and reached absorbent beds below them, these latter always yielded a supply of water rising in the well or boring. But it is known that these results do not always follow, and, although generally the reason of failure in water-sinkings is that the surface of saturation is too deep to be available, or the impermeable beds too thick to be pierced, it is certain that the best expectations founded upon sound knowledge of strata have sometimes been disappointed. Such failures might induce the notion that the circulation of water was only partial, and confined to certain rocks; and in one sense this is true, for the ready transmission of available quantities of water is no doubt so limited. Many rocks interrupt it, many disturbances of rock interfere with it, and some rocks and disturbances have the effect of checking it altogether.

But in addition to the perceptible and available circulation, here is another which is not less important, and is quite universal. Clays and granites, and some other rocks, only allow of the free passage of water through cracks and fissures in their mass; and they certainly prevent the flow of water when they come in the way and are unbroken. But amongst them water is always moving, though this kind of circulation is not to be measured and recognised by the eye. The best proof of it is found in the chemical changes constantly taking place in them, as in all other rocks that form the external crust of the earth. All, without a single exception, have been entirely modified since they were deposited, and always by the aid and in the presence of water. The changes are incessant though slow. Crystallisation is one of these results, and no one who examines a crystallised fragment of shell, and compares it with a corresponding fragment of its recent analogue, can doubt the extent of the change. The external characters of the shell may be preserved without the smallest alteration; but within, while

the mineral carbonate of lime is the same, in one case the atoms are arranged with perfect symmetry to form a transparent crystal, in the other they have been bound together by laws of structure and by the presence of life. This is only one example out of many. Change in all respects is the rule, and not the exception, in all those deposits originally made in water, and now forming part of the earth's crust. The laws of this change are among the discoveries that may be looked forward to with confidence, but at present they are imperfectly understood.

Thus, then, it appears that water exists, and is in constant circulation through the earth; that, of the rain that falls, a certain proportion entering the various rocks and strata is employed in helping this process. The operation goes on incessantly. It is not easy, nor indeed always possible, to determine where these surfaces of partial or absolute saturation may be. In every district a knowledge not only of the surface, but of the structure of the earth is necessary. In England the geologically-coloured maps of the Ordnance Survey afford an easy and ready means of applying general geology to local peculiarities, and learning as nearly as possible where the subterranean water channels exist, how they may be exhausted, and whence they might be replenished.

IV.—Effects of Clearing, Cultivation and Drainage on Water Supply.

Water supply, derived from the clouds, distributed by rain, and afterwards returned to the sea by the aid of streams or utilised by organic structures, depends on the form of the land, the extent of adjacent land, the vicinity to mountains or ocean, the form of the mountains, much more than on latitude and longitude. It is modified also by the state of cultivation of the land, the extent and nature of forest and other vegetation, and the rapidity with which the rain that falls runs off or is absorbed into the surface, as I have already pointed out.

The greater part of the land of the temperate zones, as well as within the tropics, was formerly covered with dense forest wherever circumstances were favourable for vegetation. Many districts less favourably situated for such vegetation than England are still covered with timber, and there are many parts of the continent now absolutely bare where dense forests have existed not long ago. Besides historic proof of this, in many cases there is also the evidence of our senses seen in the innumerable branches, trunks, and roots of trees, dug up in old turbaries, in boggy tracts on mountain sides, and at the mouths

of streams once the outlets of mountain valleys. In Greece the whole country was wooded in the time of Homer, and probably for centuries afterwards. There is abundant proof that the period of destruction, even on the Mediterranean shores, commenced less than 2000 years ago, and had hardly affected a very large area till within the last thousand years. These shores are now, to a very great extent, absolutely bare of vegetation of all kinds.

In discussing the influence of man, not only on the destruction and growth of trees and crops, but as exerted on climate, it is quite necessary to appeal to figures and definite statements, as we should otherwise be accused of exaggeration. In America, the most recently cleared of all countries, it is certain that in the year 1860 there was an area of some 250,000 square miles of country (160 millions of acres) under profitable cultivation, replacing the same or nearly the same area of primæval forest land that existed there 300 years ago. The climate and rainfall of North America before the disforesting are very imperfectly known, but all the evidence that exists favours the conclusion that the rainfall has diminished, that the streams have become more rapid, and that the climate is warmer in summer and cooler in winter.

Northern Europe was in a similar way a country of forests in the time of Cæsar, although now there are no large forest tracts remaining. There also the climate has changed, the rainfall has diminished, and the air is drier than before. Wherever civilized man appears the forest disappears, and cultivation takes its place. Let us consider the result of this change in the various elements of climate as far as we have facts to guide us.

There is good proof that hail and other storms depending on electrical causes have been far less frequent and severe where forests have been cut down. This has been noticed especially in the Alps, where much wood has been removed within a short time. Nor is this remarkable, for very important chemical changes are caused by vegetation, and when these, after proceeding without interruption over thousands of square miles for many centuries, are suddenly and abruptly terminated, the result cannot but be felt. A surface covered by forest is generally believed to absorb more carbonic acid and exhale more oxygen than meadows or fields.

But forests act, not only indirectly, but directly and very manifestly, on temperature. During a large part of the year cultivated lands are bare, or nearly so; forest lands never. And this of itself is a very important matter. If the power of calcareous sand to retain heat be taken at 100, arable calcareous soil may be represented by 74·3, argillaceous soil at 68·4, and common garden earth somewhat less. Humus, such as is

obtained from decayed leaves, ranks however at 49; and the soil that is clothed with forest will thus radiate heat twice as rapidly as that which is uncultivated and naked.

In Italy the removal of forest has introduced the scirocco, the effect of which is unfavourable to life of all kinds, and many of the crops have suffered thereby. Near Ravenna a pine forest, extending for about 22 English miles, being cut down, the scirocco was introduced, but was got rid of when the wood was allowed to grow again. In other parts of Italy, where the wood was cut down during the time of the French republic, to enable the manufacture of iron to be carried on, the result was at once seen in an increased severity of climate, the maize no longer ripening. The forests have since been restored, and the climate is restored also. In Belgium favourable results have been obtained by the planting of trees on the right bank of the Scheldt, where large tracts of land, formerly waste, have been rendered fertile. The produce of the plains of Alsace, in the east of France, has suffered since the forests of the Vosges were removed; and the centre and south of France has felt the influence of the *mistral* and other injurious winds only since the forests of the Cevennes have been removed. The cultivation of certain plants and trees has thus become difficult or impossible where it was once easy and natural; and as this has taken place within the period of history, and has followed the disforesting in every case where observation has been made, there can be little doubt as to the cause. Although it is difficult to verify with precision the extent of these changes of climate where accurate and detailed observations are wanting, still the testimony of experience and the comparison of historic accounts point to such a change in Europe within the last thousand years. These conclusions are fully justified and confirmed by such tabular statements as exist, and are not contradicted by any statements, either of fact or opinion. They tend to show that throughout the north temperate zone the summers are cooler, moister, and shorter than they were formerly; and that, on the other hand, the winters are milder, drier, and longer, than when forests covered a great part of the land, and cultivation was the exception, and not the rule. It is certain that the rivers and streams have also undergone change, and that where their course has not been interfered with, they are more irregular now than formerly, passing more frequently into torrents, becoming dried up more frequently, and carrying off more rapidly the heavy rains.

The influence of forests on rain is well recognised within the tropics and wherever in temperate latitudes there are means of observation. In all wooded and undrained countries the atmosphere is permanently humid, the rain and dew fertilise the soil,

and the general result is similar to that produced by the vicinity of the ocean. On the other hand, extensive tracts without wood are always dry and parched. Spain is an example of a country that has suffered much from the removal of the forests that once covered it. It is possible now to travel across hundreds of miles of the peninsula without seeing a tree except in the hollows and deep narrow valleys through which the streams run. Trees now refuse to grow on these plains, and it would take many years of careful management to replace the great forests that were once so common. But with the first belt of wood the condition of the climate would no doubt begin to alter. It would certainly be impossible to replace the old forests under the present climate, but the old climate would perhaps be restored if the natural vegetation were allowed to become arborescent or if trees were cultivated. Examples of this may be seen in Scotland, where in several places trees have been planted with very marked and favourable results. Even more striking, however, is the case of Egypt, where at the close of the last and beginning of the present century rain was a very rare phenomenon, not falling sometimes once in twelve months. Since that time Mehemet Ali and Ibrahim Pacha have planted very freely, to the extent it is said of twenty millions of trees, consisting of olive, fig, cotton-wood, orange, acacia, and plane. Rain now falls, not only on the coast, but in the interior during all the winter months.

Forests affect the supply of water to springs as well as induce a larger quantity of rain over a given surface. This arises from the protection they provide against evaporation, and the time thus afforded to the moisture to penetrate beneath the surface. In America cases are recorded where springs have greatly and steadily decreased after the clearing of land, and Mr. Marsh, in his recently published work on 'Man and Nature,' states:— "I remember one case where a small mountain-spring, which disappeared soon after the clearing of the ground where it rose, was recovered, about ten or twelve years after, by simply allowing the bushes and young trees to grow up on a rocky knoll not more than half an acre in extent immediately above it, and has since continued to flow uninterruptedly." In South America, in the valley of Aragua, in Venezuela, there was a town founded in 1555 half a league from a lake, the surrounding country being then clothed with forest. The forests were cut down, and in the year 1800 there had been for 30 years a large population on the spot. It was then visited by Humboldt, who found the town about two miles further from the lake than it had been, owing to the diminution of the water supply. Twenty-two years later political events had caused the reduction and removal of the population, and the forest had grown once more. The

waters of the lake had again risen, and had covered large tracts of land formerly under cultivation. Many other examples are on record of results of the same nature following immediately on the change from forest land to cultivation, or conversely from cultivation to a fresh growth of forest.

And it is clear that some such result must follow. When the earth is bare it parts more rapidly with its heat, and evaporation from the surface is more complete than when it is clothed with forest. A larger quantity of the rain that falls is also then retained near the surface for any limited time and the evaporation that afterwards takes place is slower and lasts longer. But even the precipitation of moisture as rain is less regular. Where the ground is bare a soil is longer in being formed, more liable to be removed by torrents, and the streams that flow through it or convey its rainfall to the sea necessarily become more rapid. Beneath a forest a swamp is often formed by the natural accumulation of trunks of trees and other vegetation, while on cultivated land such a result is almost impossible. On the other hand, the rapid flow of rivers is more apt to produce a bar or other impediment at the contact with the sea. England has suffered less than other parts of Europe from unreasonable disforesting because from its geographical position there is almost always a supply of moisture both in the atmosphere and from rain, but it seems certain that a difference has there also taken place. There has been a change of climate in every essential sense of the word—a change in the mean temperature, annual, monthly, and daily—a reduction in the range of temperature—a change in the amount and distribution of rainfall —and a change also in the habits of the rivers and streams. Many of the smaller of these have been entirely lost and swallowed up, and some are canalised or otherwise altered in volume. They have also undergone alteration in the condition of the freshets, and in the usual period and amount of the maximum and minimum discharge of their waters.

The actual quantity of woodland that should be left in a given area to secure a fair climate must evidently depend on many circumstances. In France the extent of the forests in 1750 was estimated at about 40 millions of English acres, while in 1860 the area had been reduced to one-half, or 20 millions. It is now believed that the former was not too much, and that at present a great increase is necessary if the climate and rainfall are to remain unaltered. There is certainly far too little forest in most parts of the continent of Europe.*

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* See Marsh's 'Man and Nature,' p. 28; Ansted's 'Physical Geography,' 1866, p. 421.

But, after all, disforesting is only the commencement of the change. Each kind of cultivation involves some peculiar result of its own, for as a country becomes thickly peopled nature is made to bend in various ways to human convenience. First, there is the general drainage of swamps and bogs to render the country healthy and habitable, and then follow improvements in the course of the streams to confine them within definite channels that shall run as quickly as possible to the sea. By thus decreasing the distance run the erosive power of the streams is increased, and therefore the conveying power of the water, so that one of the results of the clearing of a mountain-side may be the extension of a coast-line towards the ocean. Another result may be, as in the case of the river Po, the gradual elevation of the bed of the stream till its waters are carried between banks at a level higher than that of the surrounding country.

In like manner the drainage of shallow pools helps to increase the mechanical effect of streams, while artificial embankments limit and divert the action of the sea, recovering tracts of land subject to tidal overflow, and converting them ultimately into fields and gardens. It must be evident that the evaporation that once acted over almost the whole surface of the land is now reduced to the narrow courses of the streams except immediately after heavy rains, and that the quantity of rain absorbed into the earth must be much smaller now that the surface is dry than when it was permanently moist. In this way, therefore, two direct and important results of the introduction of civilized man are at once recognized. It is true that in each particular case the calculable difference may be small, but when the whole surface is affected it is impossible that it should not be important. One thing also leads to another. The diminution of mist arising from permanent moisture on the surface increases greatly the radiation from the surface, and therefore the evaporation. The quality of the soil is thus altered by mechanical treatment, and the moisture needed is more rapidly absorbed and utilised by miscellaneous crops than by forest-trees.

In every way the cultivation of the soil has a tendency to modify the proportion of rainfall that passes into the earth. It tends to increase this proportion by inducing in summer a greater action both of the sun and air in drying, and therefore cracking the surface, and during cold weather by exposing the rock more frequently to alternate expansions and contractions. On the other hand, it tends to diminish the proportion by running the water more rapidly from the surface and leaving a smaller quantity to soak into the strata. These are direct results. Indirectly, cultivation, even without drainage, by rendering the air more clear during fine weather, and by increasing both the hourly and daily

mean range of temperature, must affect the mean annual rainfall. Drainage necessarily assists this action. It not only clears the surface of moisture still more rapidly than before, but it even carries off much of the water that had actually entered the soil and was on its way to the rock. Thus drainage affects the springs as well as the rainfall, and doubles the result.

And although it is true that the rainfall in England depends very largely on the physical conditions of the British islands—on the vicinity, not only of a great ocean, but of a great and warm current of water and moist air crossing that ocean—on the presence of a mountain chain of moderate elevation on the western side of the island—on the general form of the land—on the adjacent lands of the continent of Europe—and on many other facts—still neither the total amount nor the distribution can fail to be influenced by those important and powerful causes to which I have directed attention. An alteration of a fraction of an inch per annum in the mean rainfall, the addition of an inch in the summer fall counterbalanced by the reduction of an inch in that of the winter months—these may seem trifling, but if persistent they effect a real change of climate, and one which will in time show itself in the vegetable and animal productions that flourish under it.

V.—Economisation of Water Supply.

The practical value to the agriculturist of all that has been said on the subject of rainfall and water storage, and the results of cultivation on water supply, can best be measured by the extent to which he may hope to make use of such knowledge, either by adapting his methods of cultivation so as to take advantage of the result of change, or by enabling him to produce a modified climate, availing himself of natural causes of change. Incidentally he may also learn in this way the means of utilising and economising the supply of rain that comes to him in the ordinary course of nature.

I think it will be evident, from all that has been said under the last heading of this article, that where all forests have been removed over large districts a combination of tree-cultivation with ordinary crops is calculated to equalise its summer and winter climates, to increase the yield from springs, and to restore to some extent the former conditions of climate. At the same time it must be remembered that in many respects the climate of England has been ameliorated rather than injured by the alterations that have taken place; and that with us there must always be so large a rainfall that there is not the same need for this modification as in other countries of Europe, where

the air is always drier. It is in France and Spain, and more especially in Greece and the Levant, that the removal of the forests has been injurious. In North America also, and in many of our colonies, the first business of the settler has always been to destroy the wood. It is probable that in many cases the destruction has been carried too far, and that the climate has suffered. On the other hand, there can be little doubt that cultivation and planting with European trees is likely to improve in a very marked manner the climate of Australia, and increase the rainfall. Thus the advantages of planting, though not unimportant even in England, where the land has been left absolutely bare, are much more likely to be felt in other countries than at home; and the English farmer must look rather to the shelter given to birds and other incidental advantages than to alteration of climate, if land that has once been cleared should be brought again under forest.

But if the increase of forest lands is neither probable nor perhaps desirable in the British islands, except, perhaps, in the Highlands of Scotland, there are many important agricultural operations going on that admit of modification to some extent, and that also have influence on climate and water-supply. At present it is usual to limit the operation of drainage to the construction and keeping in order of channels that shall carry off all surface-water as rapidly as possible to the sea. It may be doubted whether in many places, where the form of the country lends itself to such purposes, it would not be advisable to collect this drained water into reservoirs, at various levels, whence in dry seasons it might be made use of for irrigation, or for other purposes. There would thus be a double advantage gained; for the presence of these reservoirs, if uncovered, would prevent the air from becoming so dry as it otherwise would, and might thus check the burning up of the soil and crops. A few acres, here and there, occupied by a reservoir, would not be without great value, and might well be made more subservient to the ornamentation of parks and pleasure-grounds than has hitherto been the case. A portion of the water that must otherwise be diverted would thus also sink into the earth, and increase the springs. It is evident that to be of any advantage these reservoirs should be numerous, and systematically placed. It is also evident that they can only be constructed in hilly or undulating districts. On the other hand, it must not be forgotten that standing-water in the autumn months is in many localities very unhealthy.

There are no available artificial means at present known of modifying the distribution of rainfall and its total amount, except by altering the vegetation of a large extent of surface. The change of climate that has taken place already may, perhaps, be

almost entirely due to this cause and to drainage; and as clearing and draining must ever be the first operations of civilised men in a new country already covered with forest, the change must begin at once, and go on uninterruptedly until a balance has been attained. We do not know whether this is yet the case in Western Europe. It may be considered certain that it is not the case in North America, and that the tendency therefore may still be to produce a more average climate in both cases. In the northern states of the Union, and in Canada, the climate is still excessive, and will probably always continue so. In our own country it probably never has been excessive in recent times, at any rate since the introduction of civilisation; but it has been favourably modified, and may admit of improvement yet further, so far as it is improvement to equalise the temperature of summer and winter, and distribute the rainfall equally throughout the year. An extreme instance of such a climate may be found in some parts of New Zealand; and by the removal of forests that country may some day resemble England even more than it does at present. Cosmical causes, or causes affecting the earth as a planet, in its relation with the other planets of our solar system and the sun, may also have acted to some extent; and if so, they may still act, and produce further changes quite independent of human agency; but with these, or modifications of the surface arising from physical causes, we are not here concerned.

We must, I think, assume that as drainage has only recently been carried out systematically over large areas of country; as the modern style of cultivation and the removal of hedge-rows and trees wherever important farm-work is undertaken, is still imperfectly acted on; and as high-farming is still limited, the progressive alteration of climate, whatever it has been, will not cease or be checked, but rather it will increase and become more manifest. We must look forward to the seasons running yet more into one another than they now do; to the winters being more rarely extremely cold and the summers hot, and, perhaps, also to the rainfall diminishing by degrees, more or less perceptible. And this may be the case, although now and then old people may recognise and welcome a winter or a summer of the kind they remember to have been common when they were young. It is not that each particular year will be more like the average, but that the seasons will, on the whole and generally, be more moderate. What is done is done; but the effects, perhaps, are only beginning to manifest themselves; and it behoves the agriculturist to prepare for the change, and to consider how, on the whole, he can best adapt himself and his culture to it. Crops that can best grow and ripen in our cool summers and doubtful autumns should take the place of those

that can endure sharp winter-cold, but need hot days in autumn. We have long given up the vine for profitable cultivation, and have ceased to expect grapes to ripen in an average summer; but we retain some crops that are better adapted for drier climates, and hotter and more settled weather in August and September than England can make sure of. We must not in this, or in any matter, attempt to fight against Nature, though by a careful study of her operations we may modify and bend her course.

It seems to me that this is the right lesson to be learnt, from the very important fact that the climate of England is probably undergoing a modification which may continue still further in the same direction. We could not now, even if it were desired, bring things back again to their former state, restore a former condition of vegetation, and cover the surface of the soil with the oaks and beeches of former times. We must adopt another and a very different system. Accepting the change, we must work to meet it; and knowing the probable result of those plans that we find it convenient to adopt, we must prepare for a more average climate, and perhaps for a smaller rainfall, less water in the streams in dry summers, and generally a lower state of the springs. In some countries, where the supply of water is already insufficient, this might be difficult; but with us there is no danger of permanent drought; and we have only to make due use of that state of things which naturally belongs to or has been artificially produced in our country.

V.—*Field Experiments of Crude German Potash-salts and Common Salt on Mangolds.* By Dr. AUGUSTUS VOELCKER.

IF the artificial supply of potash be attended with any beneficial results to vegetation, it is likely to produce a more marked effect on poor sandy soils, naturally deficient in potash than on good agricultural clays, in which this alcali may be presumed to occur in greater abundance.

The discovery of vast mineral deposits of a variety of potash-salts in the salt-mines at Stassfurth, in Saxony, has placed within the reach of the farmer a cheap source of potash with which he may manure his fields, should experience prove such an application beneficial. There are at present several manufactories in active operation at Stassfurth, producing chloride of potassium and sulphate of potash of various degrees of purity, the least expensive form being sold under the name of Crude German Potash-salts. These salts have been tried in Germany during the last three or four seasons, on a variety of crops, some-

times with apparently marked beneficial results, at others without producing any decidedly favourable effect. These contradictory records of experience appeared to me to result probably from the great variation in the proportions of available potash which we know to exist in soils of different characters. In order to put this supposition to a practical test, and, as I thought, to give the crude potash-salts the best chance of manifesting their fertilising powers, I induced my friend and former pupil, Mr. Kimber, of Tubney Warren, to undertake for me some experiments on a very light newly-reclaimed sandy soil. The crop experimented upon was long red mangolds.

A sample of the crude potash-salts employed in the subjoined experiments analysed by me was found to have the following composition:—

Composition of Crude Salts of Potash from Germany.

Moisture	11·63
Organic matter	·73
Oxide of iron	·34
Sulphate of potash	24·03
Sulphate of magnesia	1·14
Chloride of magnesium	12·01
Chloride of sodium (common salt)	47·85
Sulphate of lime	·78
Magnesia	·52
Sand	·97
	100·00

It will be seen that beside chloride of magnesium these salts contain 24 per cent. of sulphate of potash, and nearly twice as much common salt.

Having ascertained in the preceding year that common salt alone produced a very considerable increase in the mangold crop, grown on a light sandy soil very similar to that on which I intended to try potash-salts, I considered it very desirable to eliminate, if possible, the effects likely to be produced by the common salt in the crude German salts, of which it forms so large a proportion. Several experimental plots, therefore, were top-dressed with common salt, varying in quantity from 2 to 8 cwts. per acre; and in order to get some insight into the natural variation in the agricultural capabilities of the experimental field, two plots, one at either end, and a third in the middle of the field, were left without any top-dressing. As very few fields have a properly uniform composition, or are in every part in precisely the same agricultural condition, the reservation of two, or rather three, such plots is essential for determining the limits of the variation in the natural productive

powers of the field without manure, in order to form a correct estimate of the value of the manures experimented on.

The soil of the experimental field was a rather dark-coloured sand, about 1 foot in depth, and resting on a raw yellow sand.

A portion of the soil was submitted to analysis, and the following results obtained:—

Composition of Experimental Mangold Field at Tubney Warren, Abingdon.

	Soil dried at 212° Fahr.
Organic matter	5·88
Oxides of iron and alumina	4·11
Carbonate of lime	·62
Magnesia	·22
Potash and soda	·14
Phosphoric acid	·07
Sulphuric acid	·04
Insoluble silicious matter (fine sand) and loss	88·92
	100·00

This analysis shows that in this soil sand greatly preponderates, that lime is deficient, and but very little potash and soda exist. It appeared thus peculiarly well adapted for trials with potash-salts.

The land on which the mangolds were grown was uncultivated until 1863, growing grasses of a rough, coarse kind, principally the hassock-grass (*Aira cæspitosa*).

The surface was pared and burned early in 1863, and the land drained. The greater part of the ashes were spread on the land, and oats sown in March. In 1864 another crop of oats was grown without manure. The land was then cultivated in the autumn and afterwards ploughed and subsoiled. It was then ridged up with farmyard dung and mangolds—long red, drilled on the 27th April last with 3 cwts. superphosphate per acre. The plants came up well; and after they had been hoed and singled, common salt and salts of potash were applied separately in various quantities on the 1st July.

On the 6th July there was a heavy fall of rain, and again on the 13th another soaking rain, which I considered would wash into the soil all the most soluble parts of the salts.

The effect of the common salt was soon apparent. By the first week in August the eye could clearly detect different shades of colour in the leaves of the different plots, which by the middle of the month became still more marked. The leaves of the mangolds dressed with salt had a decidedly lighter colour than the rest; those dressed with potash-salts were somewhat darker and less yellow in hue; and where no top-dressing was

applied the leaves had a darker, more bluish-green colour, inclining to purple.

Mr. Kimber writes to me:—"During three seasons I have observed that common salt applied to young growing mangold plants on this sandy soil has the effect of producing a greater development of leaf and a kinder growth of the bulb with less root.

"When a soil is deficient in any one of its necessary constituents, or when that which the growing plant requires in its circulation is not obtainable in sufficient quantities, a forked growth of the roots is generally the result. The difference in this respect of two heaps of mangolds placed side by side, one grown with salt, the other with none, is very marked. I have also observed that turnips grown here with salt have come up less rooty than the others without salt; but the difference is not so great as in mangolds.

"These remarks are not intended to apply generally and to all soils, they only relate to this particular soil and the last three seasons."

Mr. Kimber made some notes on the 19th August, 1865, and as he was quite ignorant of the arrangements of the plots, his observations are of particular interest.

Notes on Experimental Mangold Plots, made 19th August, 1865.

Plot 1.—Nothing	Leaves dark in colour, inclining to a purple tint.
Plot 2.—Salt, 6 cwts. ..	The leaves four or five shades paler in colour than Plot 1, and having a more luxuriant appearance. Half as much again leaf and far superior bulbs to Plot 1.
Plot 3.—Potash, 3 cwts. ..	Not quite as good as Plot 2. Leaves a shade darker.
Plot 4.—Salt, 3 cwts. ..	About as Plot 3. Leaves a shade paler.
Plot 5.—Potash, 1 cwt. ..	Not quite as good as Plot 4. Leaves a good shade darker.
Plot 6.—Nothing	Not quite as good as Plot 5, and the leaves a shade darker.
Plot 7.—Salt, 2 cwts. ..	Much more leaf and two shades paler.
Plot 8.—Potash, 2 cwts. ..	About as Plot 7. Leaves a shade darker.
Plot 9.—Salt, 4 cwts. ..	More leaf than Plot 8, and a shade paler.
Plot 10.—Potash, 4 cwts. ..	About as Plot 9. A shade darker.
Plot 11.—Salt, 8 cwts. ..	Very much larger in leaf and bulb than Plot 12, and three or four shades paler. About the same as Plot 10.
Plot 12.—Nothing	The same as Plot 1.

The roots were taken out of the ground, topped, cleaned, and weighed on the 10th November, 1865.

The following Table shows the results that were obtained, the

arrangements of the different plots, and the quantity and kind of top-dressing employed:—

EXPERIMENTS with CRUDE POTASH-SALTS and COMMON SALT on LONG RED MANGOLDS at TUBNEY WARREN, ABINGDON.

Plots of $\frac{1}{21}$ Acre.	Top-dressing per Acre.	Number of Roots per Plot.	Produce per Plot.	Produce per Acre.	Increase over Plot 1.
			cwts. qrs. lbs.	tons. cwts. lbs.	tons. cwts. lbs.
No. 1	Nothing*	636	12 0 15	12 2 76	Nothing.*
" 2	Common salt, 2 cwts. ..	592	18 3 24	18 19 32	5 14 80
" 3	Crude potash-salts, 3 cwts.	620	17 1 18	17 8 24	4 3 72
" 4	Common salt, 3 cwts. ..	632	18 0 26	18 4 72	5 0 8
" 5	Potash-salts, 1 cwt. ..	632	15 1 13	15 7 36	2 2 84
" 6	Nothing*	619	13 0 0	13 0 0	Nothing.
" 7	Common salt, 2 cwts. ..	711	16 2 24	16 14 32	3 9 80
" 8	Potash-salts, 2 cwts. ..	685	16 2 2	16 10 40	3 5 98
" 9	Common salt, 4 cwts. ..	713	19 1 17	19 8 4	6 3 52
" 10	Potash-salts, 4 cwts. ..	719	21 2 5	21 10 100	8 6 36
" 11	Common salt, 8 cwts. ..	703	21 3 21	21 18 84	8 14 20
" 12	Nothing*	698	14 2 14	14 11 68	Nothing.

tons. cwts. lbs.
* Average of 3 nothings 13 4 64

The preceding experiments suggest the following remarks:—

1. The weights of the produce on the three plots not top-dressed with either common salt or potash-salts show variations amounting to 2 tons 9 cwts. per acre. Differences in the weight of the produce on other plots amounting to 2½ tons per acre, therefore have to be ascribed rather to the variable agricultural condition of the different plots of the experimental field than to the top-dressings used.

2. The results obtained on Plots 2 and 7 evidently show that such natural variations in the productive powers of the soil really existed in different parts of the same field. Plots 2 and 7 were both top-dressed at the rate of 2 cwts. of common salt per acre, whilst Plot 2 produced an increase of 5 tons 14 cwts. 80 lbs. over the average yield of the undressed plots. Plot 7 gave only an increase of 3 tons 9 cwts. 80 lbs., or 2 tons 5 cwts. less. The limit of variations in the weight of the produce of Plots 2 and 7 it will be seen agrees closely with the difference in the weight of mangolds on the undressed Plots 1 and 12.

3. Making due allowance for the natural variation in the productive powers of different parts of the same field, common salt, it will be noticed in every instance, gave as good a result as an equal weight of the more expensive crude potash-salts.

4. It will further be seen that the larger doses of salt produced a greater increase than the smaller. Thus 3 cwts. of salt

per acre gave an increase of 5 tons 8 lbs. of clean mangolds, 4 cwts. an increase of 6 tons 3 cwts. 52 lbs., and 8 cwts. of common salt an increase of 8 tons 14 cwts. 20 lbs. per acre.

5. As the crude potash-salts used in the preceding experiments contained twice as much common salt as sulphate of potash, and common salt gave as much increase as an equal weight of crude potash-salts, it is more than doubtful whether the potash in the latter had any share in increasing the crop on the plots dressed with crude potash-salts.

6. The preceding experiments, it must be confessed, are rather calculated to demonstrate the utility of common salt as a top-dressing for mangolds, on light, sandy soils, than that of potash.

It would, however, be rash to decide on the strength of a single series of experiments that the artificial supply of potash, unfavourable as it has proved to be in the case before us, is useless under all circumstances. I therefore wish to suspend my judgment on the practical utility of this and other cheap forms of supplying potash to the land until I shall be in possession of more extensive and reliable practical evidence than at present.

Laboratory, 11, *Salisbury Square, Fleet Street, E.C.,*
February, 1867.

VI.—*Statistics of Live Stock and Dead Meat for Consumption in the Metropolis.* By ROBERT HERBERT.

THE heavy losses occasioned by the Cattle-plague in 1866 produced a considerable falling-off in the supplies of English and Scotch beasts to the great Metropolitan Market during the last six months of that year. The total number brought forward, including the arrivals from abroad, amounted to only 148,320 head, against 181,400 in the corresponding period in 1865, being a deficiency of 33,080 head. But, since nearly two-thirds of the English beasts and nine-tenths of the supplies from Scotland came to hand in far better condition than in the previous season, the falling-off in the quantity of meat was trifling. Indeed, we believe that London was far better supplied with animal food than at any time since 1864. This may appear somewhat strange, considering that about 250,000 bullocks were carried off by disease in 1866, and that the importation of live stock from certain districts in Holland has been prohibited. But it may be observed, that the slaughtering of stock in various parts of England and Scotland, for consumption in the metropolis, has

been greatly on the increase; and that in the six months, about 100,000 tons of meat came to hand from various Continental ports. The dead-markets have, therefore, been fully supplied, and the upward movement in the value of live stock has been checked. Nevertheless, meat, with the exception of pork, is a dear commodity, and likely to continue so for several months. The average value of inferior beasts was 3*s*. 6*d*. per 8 lbs., against 3*s*. 2*d*. in the same time in 1865. Middling stock sold at an average of 4*s*. 8*d*., or 2*d*. higher than in the previous years; but the value of prime meat—5*s*.—was unaltered. The improved weight and quality of the beasts brought forward account for the slight rise in the price of inferior animals. The moderate importations of foreign-cured provisions have failed to have much influence upon the value of live stock in this country.

Supplies of sheep have been unusually small—viz., 708,620 head, including the animals from abroad, against 890,160 head in the corresponding period in 1865, and 769,814 in 1864. Notwithstanding that most breeds appeared in good condition and of full average weight, the best Downs and half-breds were in good request. Long-woolled sheep were steady in value. At one period the best Downs were worth as much as 6*s*. 6*d*. per 8 lbs.

Calves came slowly to hand, the total number not exceeding 12,291 head; prices have consequently been high both for English and foreign, the latter of which have formed the bulk of the supplies.

The total numbers of stock exhibited in the six months were:—

	Head.
Beasts	148,320
Sheep	708,620
Calves	12,291
Pigs	17,480

In the six previous seasons, these were:—

Total Supplies of Stock exhibited.

	Beasts.	Cows.	Sheep and Lambs.	Calves.	Pigs.
1860	145,420	3015	762,740	15,766	15,470
1861	149,750	3187	774,260	12,441	20,116
1862	159,450	3148	759,671	12,579	18,220
1863	168,232	3127	761,070	14,822	17,550
1864	177,944	3221	769,814	17,967	19,306
1865	181,400	2177	890,160	21,532	16,151

The supplies of pigs sent to this market fell off in 1866, although the number in England rapidly increased. The enormous quantities of pork disposed of in Newgate and Leadenhall

accounts for this as also for the fall in prices, which gave way quite 6*d.* per 8 lbs. The highest quotation did not exceed 4*s.* 8*d.* per 8 lbs.

In the last six months of the following years, the supplies of English, Scotch, and Irish beasts were as under :—

District Bullock Arrivals.

	Northern Districts.	Eastern Districts.	Other parts of England.	Scotland.	Ireland.
1860	66,140	9500	20,500	1151	7,852
1861	71,450	2500	9,700	4586	14,340
1862	74,570	5050	19,620	3307	14,820
1863	66,510	3850	21,250	3213	11,280
1864	60,350	8400	19,400	3625	7,079
1865	52,270	1600	20,070	4512	5,011
1866	35,900	2700	16,340	1844	4,170

We here see the effects of the ravages committed by disease. The Northern districts furnished 16,370 head of beasts less than in 1865. The slight increase in the arrivals from Norfolk, Suffolk, &c., was chiefly composed of half-fat stock.

The total imports of foreign stock into London only were confined to 378,180 head. In the corresponding period in 1865, that supply was 557,875 ; and in 1864, 362,709 head. This falling-off arose from the Orders in Council prohibiting the importations of stock from Holland. Those Orders have been somewhat relaxed; still, there are certain districts in Holland proclaimed as infected with disease. Private letters have informed us that heavy losses were sustained by the Dutch graziers in 1866, and that, even now, disease is pretty general. The return on the following page shows the imports of foreign stock into London during the last six months of 1866.

The supply from France was of full average condition. The Danish bullocks were remarkably healthy, whilst the arrivals from Spain and Portugal were composed of really good animals. The enormous demand for Spanish stock in France has prevented the arrival here of increased numbers.

Imports at Corresponding Periods.

	Beasts.	Sheep and Lambs.	Calves.	Pigs.
1865	88,775	399,220	19,535	50,445
1864	76,922	238,121	16,793	30,803
1863	61,435	241,209	17,497	18,936
1862	57,356	250,140	19,610	17,279
1861	59,049	266,249	19,715	25,919
1860	59,817	243,804	19,594	21,510

Imports of Foreign Stock into London during the last Six Months of 1866.

From	Beasts.	Sheep.	Lambs.	Calves.	Pigs.
Aarhuus	9	11	..	..	..
Amsterdam ..	7	206	301	29	..
Antwerp	1,106	73,418	3,988	4,092	2,815
Boulogne	5,763	4,810	69	1,138	91
Bremen	5,816	2,622	7,916	170	13
Cadiz	1,746	..	..	..	..
Caen	2,758	89	..	627	187
Calais	..	472	..	823	179
Copenhagen ..	..	137	..	..	..
Deauville	2,239	266	..	88	17
Dieppe	2,956	2,137	..	2,037	46
Dordt..	213	..	..	..	..
Dreux	529	22	..	..	..
Dunkirk	105	209	..	101	..
Gerstemunde ..	946	1,958	..	5	..
Gothenburg ..	1,990	1,706	..	458	120
Hamburg	10,534	57,282	..	191	3,382
Harlingen	10,179	45,298	1,137	2,362	4,605
Havre	313	190	..	95	..
Honfleur	2,057	491	2	81	12
Königsberg ..	..	50	..	..	..
New Dieppe ..	29	2,723	..	..	..
Oporto	1,289	..	..	..	..
Ostend	706	2,317	31	2,165	80
Rotterdam ..	..	..	..	..	7,705
Stettin	65	..	..	..	..
Stockholm.. ..	77	119	..	..	..
St. Petersburg ..	897	..	..	..	..
Tonning	32,004	35,519	5,839	4	..
Tromville.. ..	8,367	210	..	78	..
Vigo	139	..	..	..	..
Total ..	92,839	232,262	19,283	14,544	19,252

Inferior beasts produced rather more money than in 1865, owing to their improved condition. Middling stock was likewise dearer; but prime animals' prices were about stationary. All breeds of sheep suffered a decline.

Average Prices of Beef and Mutton.

BEEF.—Per 8 lbs. to sink the Offal.

	1862.	1863.	1864.	1865.	1866.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Inferior..	3 2	3 4	3 6	3 2	3 6
Middling	4 0	4 2	4 6	4 6	4 8
Prime	4 10	5 0	5 6	5 4	5 4

MUTTON.—Per 8 lbs. to sink the Offal.

	1862.	1863.	1864.	1865.	1866.
	s. d.	s. d.	s. d.	s. d.	s. d.
Inferior	3 8	4 0	4 2	4 6	4 0
Middling	4 8	5 0	5 2	5 6	5 2
Prime	5 6	5 10	5 10	6 8	6 2

The supplies of rough fat having been good, prices have been moderately low. The latest quotation was 2*s.* 3½*d.* per 8 lbs.

Newgate and Leadenhall were heavily supplied with meat, but prices fluctuated considerably. The highest quotation for beef was 5*s.* 4*d.*, the lowest 3*s.* 2*d.* per 8 lbs.; mutton ranged from 3*s.* 2*d.* to 5*s.* 4*d.*; veal, 4*s.* 4*d.* to 5*s.* 8*d.*; and pork, 3*s.* to 4*s.* 8*d.* per 8 lbs. by the carcase.

The wool trade was in a depressed state, owing to the unusually heavy importations from our colonies. The public sales passed off heavily, at 1*d.* to 2*d.* per lb., and very few transactions took place on account of foreign houses. Apparently, we shall have an enormous import from our colonies this year, as we learn that the clip has turned out very large. The total quantities of wools, in bales, received from all sources in the last five years were:—

	Bales.
1862	567,668
1863	596,326
1864	670,907
1865	685,634
1866	790,458

The value of English wool, at the close of 1865 and 1866, was as follows:—

	1865.			1866.		
	s. d.		s. d.	s. d.		s. d.
Fleeces:—						
Southdown hoggetts	1 9½	to	1 10	1 6½	to	1 7
Half-bred hoggetts	1 11½	to	2 0½	1 7½	to	1 8½
Kent fleeces	1 11½	to	2 0½	1 7	to	1 8
Southdown ewes and wethers	1 8½	to	1 9	1 4½	to	1 5½
Leicester ditto	1 10½	to	2 0	1 6	to	1 7
Sorts:—						
Clothing and picklock	1 10	to	1 11	1 7½	to	1 9
Prime and picklock	1 8	to	1 8½	1 6	to	1 7
Choice	1 7	to	1 7½	1 5½	to	1 6
Super	1 6	to	1 6½	1 4½	to	1 5
Combing:—						
Wether matching	1 11½	to	2 0	1 8	to	1 8½
Picklock	1 8	to	1 9½	1 5½	to	1 6½
Common	1 5	to	1 6	1 3½	to	1 4
Hop matching	2 0	to	2 0½	1 10½	to	1 11½
Picklock matching	1 8	to	1 9½	1 7	to	1 7½
Super ditto	1 5	to	1 7	1 4½	to	1 5

The fall in 1866 was, no doubt, chiefly occasioned by the enormous influx of colonial wools, and the limited re-exports, because our shipments of woollen goods last year were on a most extensive scale, especially to the United States, the dealers in which country are now buying large parcels of wool at the Cape of Good Hope, for direct shipment to New York.

4, *Argyle Square, St. Pancras.*

REPORTS

OF THE COMMITTEES APPOINTED TO INVESTIGATE THE PRESENT STATE OF

STEAM CULTIVATION.

VII.—*The Report of the Inspection Committee (No. 1) deputed by the Royal Agricultural Society of England to enquire into the Results of Steam Cultivation in the Counties of Norfolk, Suffolk, Cambridgeshire, Huntingdonshire, Hertfordshire, Essex, Surrey, Kent, Sussex, and Hampshire.*

THE following instructions were issued by the Society, for the guidance of the three Inspection Committees.

Each Committee will be furnished with :—

1. A list of the farms in the district assigned to it on which steam cultivation has been adopted.

2. The replies received from the owners of steam apparatus to the schedule of questions addressed to them by the Society.

3. A list of the farms selected for inspection. Although the Inspection Committees are not to consider themselves precluded from inspecting a farm which is not on their list, on being satisfied that there are sufficient reasons for doing so, it must be their object to limit themselves as nearly as possible to the number of days allotted to the districts assigned to them. In order the better to accomplish this they will be at liberty to omit inspecting any of the selected farms which, from information received, they may consider not to possess any especial interest, more particularly if distant from their main route. In either case they will be expected to report to Hanover Square their reasons for deviating from the prescribed list. In the exercise of this power the Inspection Committee are requested to keep prominently in mind that one of the main objects of the enquiry is to obtain a report of the results of the adoption of different systems of cultivation, and of different kinds of steam apparatus, and their power of adaptation to large or small farms, with any other points which they may consider deserving of notice.

4. The enquiry should be specially directed to the following particulars :—

i. The depth and nature of the tillage, and its cost per acre, including the various items of expenditure for each kind of work.

ii. The age of the machine and the amount paid annually for repairs: the nature of breakages and their causes.

iii. How far, by the adoption of steam cultivation, the drainage of strong lands has been assisted, and the cropping of the farm been

changed—more especially to what extent autumn cultivatic increased the growth of green crops, and the productiveness soil.

iv. The number of working days on which the engine power has used for the purpose of steam cultivation on or off the farm.

v. The number of days on which it has been used for other purpo or off the farm, the nature of the work done, daily cost and a charged when let on hire.

vi. The number of days lost by breakage and other causes.

vii. In the case of steam-ploughs, &c., let out for hire, what loss of has occurred from the non-employment of the men, this bei item of expense against the apparatus.

viii. The most economical mode of supplying water for steam vation.

ix. The best method of arranging and forming roads and hea for steam cultivation.

COMMITTEE No. 1 consisted of:—

1. Mr. Howard Reed.
2. Mr. John Hemsley, of Shelton, Newark, Notts.
3. Mr. John Hickin, of Dunchurch, Rugby, Warwickshi

To the first-named gentleman was entrusted the dut drawing up their Report.

TO THE PRESIDENT AND COUNCIL OF THE R.A.S.E

Your Committee No. 1 completed their duties in 22 having in that period visited 36 farms.

With one exception they were welcomed with the gr cordiality, and every facility was given them for the prosec of their enquiries.

They have considered it desirable generally to furnish a report of each visit; to these reports they have appended a general conclusions drawn from what they have seen.

The Reports will not follow the order in which the were made, but will be more conveniently distributed into classes, one for Heavy-land farms, a second for Medium and a third for Light-land farms. This arrangement, Committee are aware, will break up the continuity of the tive, but in as far as it will best subserve the practical obje the enquiry they consider it preferable.

Your Committee beg leave to prefix to the Reports a few re relative to the circumstances under which they made their i tigations, and the special difficulties which met them i prosecution of their duties. Their labours commenced o 3rd and terminated on the 27th of September. Throu

this period there was one day only in which rain did not fall. It will be within your remembrance that the latter part of July and the whole of August had been similarly wet, and that the harvest everywhere was thrown backwards three or four weeks. The consequence was that nearly all those who received our visits were found to be either in the middle or towards the close of harvest, with nothing to show in the shape of Autumn Cultivation either done or doing. Notwithstanding these discouragements, it was considered advisable to go on. The rain was not allowed to interfere in the slightest degree with the plan laid down, and though in many cases it partially prevented the proper inspection of the farm, and in many more did totally prevent our seeing the steam tackle at work, it could not, of course, interfere with such collection of statistics and opinions, and such personal intercourse with the gentlemen visited as could be carried on under cover. For the purposes of this enquiry the season must be considered to have been singularly disadvantageous. Further disappointment was experienced by the general dearth of anything like accurate data relative to the amount of work done and the cost of doing it. A few instances were met with in which considerable attention had been given during the first or second year of steam tillage to drawing out a debtor and creditor statement; but scarcely anywhere had this method been persevered in. Its discontinuance, however, was almost always attributed to the fact that purchasers having satisfied themselves of its economical value in the first or second year, had discontinued a practice which entailed a great deal of work without any accompanying advantage.

To some readers it may appear to be a matter of small consequence that the steam tackle should be seen at work; but in almost every case where it was so seen, it was discovered that the owners varied either the apparatus or the use of it, to suit their special circumstances. These special changes, to overcome special difficulties, are either overlooked in mere conversation or imperfectly understood if described; being often confined to the mode of working, nothing but the observing eye detects them, and duly appreciates their worth. Your Committee therefore very much regret the loss of the opportunity, wherever it did not occur.

It must be further remarked that the comparison instituted in this enquiry is only between Steam-cultivated farms. Of the adjacent farms nothing was seen beyond the glimpses of them afforded from the railway or the high road. A more extensive survey would perhaps have shown that neighbouring farmers

were content to abide by the employment of horse power, because they could point to fields so cultivated which did not show to a disadvantage beside lands tilled by steam power. The superiority in either case depends, not upon the power itself, but upon the man who wields it. Mr. Kersey Cooper said during the visit of the Committee to him, "I have been over many steam-cultivated farms without perceiving any advantage, and I have been over others where I have seen as many advantages as I can show myself. In a great many instances steam cultivation is not a profitable investment, not from any defect of power or mechanical construction or outlay, but because few take the advantage they should and might do from it; here, as elsewhere, success is only obtained when one combines business habits with a knowledge of scientific principles." This remark entirely concurs with our experience, which goes to prove that it is the man, and not the apparatus, to which the results are mainly due.

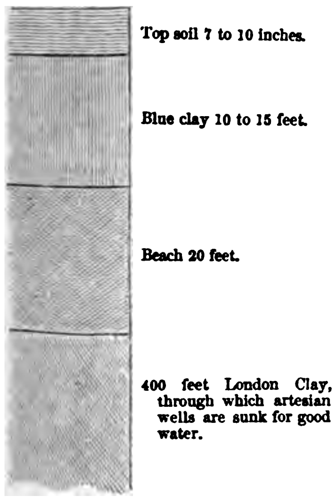
Much difference of opinion was encountered as to the character of the soil under consideration. Almost invariably it was represented as unusually heavy. For this reason one question asked was, How many horses do you use in ploughing one acre to a depth of 6 inches? These answers corrected, where practicable, by personal observations, enabled us to classify the farms according to the texture of the soil.

The statements contained in each Report are simply the condensed results obtained from the questions put. Where the Committee venture to express their own opinions or to make a suggestion, their responsibility for the same has generally been made sufficiently clear. They have been careful to ascertain the price of manual labour, of horse power, and of coal, &c., in each district, as well as the various estimates of wear and tear, maintenance, &c., and have avoided the intrusion of what are termed "received data." It has not been considered necessary in every case to carry out a calculation exhibiting the price per acre; but such data have been furnished as will enable any reader to do this for himself.

SECTION A. HEAVY-LAND FARMS.

No. 1. Mr. W. T. Allen, Little Stambridge Hall, Rochford, Essex, September 4. This gentleman occupies 3000 acres of land, 500 acres being grass. That part of the land which is moderately stiff is around the house at Stambridge. The 1700 acres of heavy land is part of Wallasea Island, which contains in all 3000 acres. The soil of this island is a stiff blue clay,

warped by the sea to a depth of from 7 to 10 inches. The section is as follows:—



The steam-plough is useful on the home farm; it is indispensable on Wallasea, where horses cannot plough the required depth. The land lies all or nearly so in stetches, 7 or 8 feet wide, water-furrowed. Some hesitating attempts have been made to lay it flat, and these having generally failed, a bar is put against progress in this direction. The fact is that the initial work of drainage remains to be done, as is often the case in Essex, owing to a conviction either that there is no fall, or that the clay will not permit of the descent of rain-water. The farm lies well for steam; the fields are large, and some have been made larger by the removal of fences. At home a good supply of water is obtained from ponds; in Wallasea from five artesian wells, which produce water of excellent quality. Great changes have been effected in the system of culture; bare fallows every sixth year have been abandoned. Italian rye-grass or tares now take their place. These are mown for cattle soiled in the yards. Sheep are kept—not a breeding flock, but hoggets purchased in spring and sold before winter in store condition. Mr. Allen spoke very confidently of the increased bulk of his crops since the application of steam; no special comparative instances were adduced; but this opinion would, in Mr. Allen's case, be founded on accurate observation. He experiences just those difficulties which any one would expect to meet with who attempted to cultivate by steam a heavy-land farm not previously drained. In a wet time, of course, the hindrances due to rain are increased.

The *Apparatus* was bought of Messrs. J. Fowler and Co. in 1862. It consisted of an *engine* of 14-horse power, a 4-*furrow plough*, a *cultivator*, 800 yards of rope, anchor, and porters; price 1000*l.*

There is upon the farm another steam-engine of 8-horse power. Both are employed for thrashing, grinding, and other work.

Repairs, Renewals, Wear and Tear.—The main expenses are

on the *engine*, particularly the travelling parts; the drums have proved expensive. Since 1862, 750 yards of new rope have been bought, and the present rope, now in its fourth season, is about one-third worn. The total expenses for repairs for the year 1865 were 115*l.*; the average expenses since 1862, 100*l.* per annum. All is kept in good repair by a first-class engineer, who superintends the two engines and all the machinery.

Work done.—During a day of ten hours, with plough or cultivator, including removals, about 8 acres a day, 8 to 12 inches deep. Since hay-crop was harvested, to give the latest particulars, 1st July, 1866, 323 acres have been ploughed or cultivated. It is observable that but for steam not 20 acres would have been done. This land had been under rye, grass, &c.; it is all well cleaned, and in fine tilth.

Cost of Work.

	£.	s.	d.
Manual and Horse-labour per day:—			
Engineer	0	3	0
Engine-driver	0	3	0
Ploughman	0	3	6
Anchormen	0	3	0
Water-cart, man and horse	0	5	0
3 boys	0	3	0
	1	0	6
2*d.* an acre per day is offered to the men as an inducement to work, say	0	1	4
	£.	s.	
The coals cost per day	0	10	4
Oil	0	0	8
Removals	0	0	7
	0	11	7

Mr. Allen directed us to his computations of the expenses between June 13th, 1862, and 10th October, 1862. They were as follow:—

	£.	s.	d.
Labour of 3 men and 3 boys, 103 days	86	18	2
53½ tons of coal at 20s. per ton	53	10	0
17 gallons of oil	3	8	0
1 horse 103 days carting water and coal	25	5	6
6 pairs of horses shifting from field to field ..	3	0	0
10 dozen points	5	11	0
Skifes and porters	5	10	0
	183	2	8

This account includes some repairs, but probably not the engineer.

In this time (103 days) were scarified and ploughed 562 acres, stoppages and removal included,—that is, about $5\frac{1}{2}$ acres per day; much less than the performance in 1866, after years of experience, and after all the land has been once deep worked. This comes to 6*s*. 6*d*. an acre, to which may be added 6*s*. 3*d*. an acre for wear and tear, maintenance, and interest on the whole prime cost of the tackle. The horses have not been reduced;* but much more work is done and more crops are taken. The tackle has worked abroad; the charges have been 15*s*. for cultivating, and 20*s*. for ploughing. We saw it in operation. The engine looked somewhat worn. The plough, cultivator, and rope were in a good state, and the land lay in fine style.

No. 2. Mr. C. C. Harvey, Foulness Island, South Essex, September 4. To gain this farm we passed through Paglesham from Stambridge, and took the ferry-boat down the Roach and Crouch rivers, over the oyster-beds, some three miles, to Mr. Harvey's landing-place. The island contains 5000 acres. On this space 600 people live in very primitive fashion. It seems scarcely credible that the post should take a week now to reach any point in England and Wales from London; yet the letter which we forwarded to announce our visit only arrived the day before we made our appearance, and had certainly been six days on the road. The island has another approach from Southend by the Maplin sands, which are about to be flooded with the sewage of London. The culvert that is to bring it will cross the Roach near this farm, and will run across the island.

The 2 feet of staple consists of a series of deposits, marine and fresh water, lying upon the London clay, which is found at a depth of about 40 feet, the intervening strata being sand, gravel, and blue clay. As with Wallasea (No. 1), the London clay is pierced for good water in numerous places by Artesian wells, from 300 to 400 feet deep. Mr. Harvey's farm is so supplied. Two-thirds of the island belongs to Mr. Finch, a Rutlandshire squire. No permission is needed for grubbing hedgerows or felling timber, for the fields, which are large, are divided by ditches, and trees, if ever they did exist, now form a carboniferous deposit far below the chalk which underlies the London clay. Our acquaintance with the farm was made during our efforts to gain the house from the river-bank through a pelting rain. The scene was dreary in the extreme; it was one in which no heart, save that of a duck or a heron, could take pleasure. Our observation tended to confirm what Mr. Harvey told us of the strength of the soil, namely, that three horses had quite enough to do in turning a furrow-slice 7 to 8 inches deep. Mr. Harvey does not agree with his neighbour, Mr. Allen, in the unprofitableness of

drainage-works; but an obstacle presents itself to deep drainage in the defective outfall which is regulated by the cill of the sluice in the river-bank, which is only 5 feet down. Drainage, however, in Mr. Harvey's opinion, does not do away with the necessity for stitches and water-furrows. The course of cropping in the neighbourhood is as follows:—clean fallow, mustard, wheat, clover, wheat, beans, wheat. By means of steam Mr. Harvey now produces roots, and gets a tare-crop between the wheat-stubble and turnip-crop.

The *Apparatus,* manufactured by Messrs. Fowler, was bought in the autumn of 1862. It consists of an engine of 14-horse power, double cylinder, traction, a 4-furrow plough, fitted as a cultivator, 800 yards of rope, an anchor, porters, &c.; price 900*l.*

Repairs, Renewals, Wear and Tear.—During the first year the repairs are said to have been "frightful:" every conceivable accident occurred; never a day passed without a smash, or a breakage, or without serious delay. But Mr. Harvey stuck to the machine through all adverse circumstances, trained himself and his men to use it, and has outlived the jeers of those who are always ready to depreciate the efforts of men of progress. Breaks and delays are now never known. No account of repairs has been kept. We were presented with a rough estimate—100*l.* in two years. The great loss has been with the travelling parts of the engine, especially the clip-drum. *Rope* in a soil which has no pebbles does not wear much. Of new rope only 250 yards have been required.

Work done, its Cost, and Mode of doing it.—During a day of ten hours about 8 or 9 acres are ploughed, not including stoppages or removals. The mode of preparing for the green and root crops is as follows:—wheat-stubble, broken up and crossed by steam, horse-ploughed, sown with tares, tares fed off with sheep, tare-stubble scarified and ploughed 15 inches deep by steam. This produces a far better seed-bed for seeded mustard than can be gained by those who depend simply on horse-power, and allows of the extra crop. Work can be usually prosecuted from May till October. The apparatus was not bought for his own farm merely, but to work on neighbouring farms, like the thrashing-machines, of which he owns several. He has been doing a little contract-ploughing, at 12*s.* an acre, 9 to 10 inches deep; but is disappointed in the demand, even at this low rate. From what has been said it may fairly be supposed that enterprise is a rather rare quality on Foulness Island. Mr. Harvey expressed a desire for the 2-engine system, so that he might dispense with the anchors, gain a direct pull on the implement, and move from

place to place with facility. The following is a copy of a paper, prepared by Mr. Harvey, to show what has been done since July, 1865:—

August, 1865.—Steamed in 17 days 113 acres, or 7 acres per day, 10 to 12 inches deep: 3 men, 5*s*. per day each; 2 boys, 2*s*. per day; 1*s*. 10*d*. extra divided amongst the company.

Total manual-labour £26 10 2

September and October, 1865.—Steamed 162 acres in 40 days, or 4 acres per day, same average depth as above: 1 man, 3*s*. 6*d*. a day; 2 men, 2*s*.; 2 boys, 1*s*. 6*d*. each; 10*d*. per acre extra distributed amongst the company.

Total manual-labour £27 15 0

June, &c., 1866.—Steamed 151 acres in 36 days, or 4¼ acres per day: 1 man, 3*s*. 6*d*. per day; 2 men, 2*s*.; 3 boys, 1*s*. 2*d*. per day; 11*d*. per acre distributed amongst the company.

Total manual-labour £26 14 5

July, 1866.—Steamed 100 acres in 25 days, or 4 acres per day: 1 man, 3*s*. 6*d*.; 2 men, 2*s*.; 3 boys, 1*s*. 2*d*. per day; extra, 11*d*. per acre.

Total manual-labour £18 6 3

Coal, 1*l*. per ton home; consumption, 15 cwts. per day of 10 hours.

The farm, which consists of 300 acres, though nearly all arable, is not of sufficient extent to employ so large an apparatus.

Mr. Harvey laid particular stress on the value of copper fire-boxes and brass-tubes, such as those sent out with some of Ransome's engines, particularly when the water is apt to leave a large deposit. He spoke of engines so fitted, which having been in constant work since 1857, without repairs in tube or fire-box, are now as good as they were the day they came from the Orwell Works. The difference in price between copper and iron in an engine of 7-horse power is 50*l*. When done with, the metal is still valuable.

No. 3. The Right Hon. the Earl of Leicester, Holkham, Norfolk, September 11. In February, 1861, Lord Leicester purchased a set of tackle for a farm of 500 acres of land just reclaimed from the sea, which so late as 1857 was under water. The soil, like all alluvia, is without stones. About two-fifths of the area is a heavy blue clay thinning out to a sand on one side of the farm. The subsoil is clay. The rest is being clayed. Two horses plough 3 roods a day 6 to 7 inches deep. A great deal of preliminary work had to be done before the land was fit to receive horses. Creeks had to be filled up, hollows levelled, ditches cut dividing the area into square plots, roads constructed, and drains made. When this was done steam was applied. The fields are of such dimensions, 280 yards square,

that 600 yards of the rope exactly suits. They are uniformly cultivated from the roads. The under drainage is done at a depth of from 2 to 4 feet, 12 yards apart in clay, 24 in sand. Water is plentifully obtained on the land side of the old sea-bank, and is of good quality.

Of this 500 acres, 260 acres only had been cultivated by steam up to December, 1862, when the bank broke, and the sea regained possession. Until March, 1864, nothing could be done. When the sea was again excluded, the land was long too wet to work. Since that date steam has been used to great advantage.

The *Apparatus* was bought of Messrs. Fowler in 1861. It consists of an engine, bearing Kitson and Hewetson's name, of 12-horse power, double cylinder, traction, 600 yards of rope, 1 4-furrowed plough, 1 cultivator, and a subsoiler. Price 885*l.*

Repairs, Renewals, Wear and Tear.—We saw the tackle at work. The 4-furrowed plough was carrying 3 furrows 9½ inches deep, with 65 lbs. steam pressure. All was in a good state and carefully kept; the slack rope well supported. The engine is cleaned out once in 6 weeks; width of front travelling-wheels of engine 1 foot 4 inches; of back wheels, 1 foot 10 inches. The bush of the clip-drum, being of cast-iron, has been twice renewed; beyond this, there has been no considerable wear of the tackle. In this, as in some other engines which we inspected, we considered that there was too small a space for dry steam. The engine is engaged about 170 days a year: 20 for thrashing, chaff-cutting, &c., and 150 for tillage on this and the Park Farm. Two years ago the whole apparatus was overhauled, refitted with all the recent improvements. Excluding these additions, not more than 100*l.* have been expended, apart from the *rope*, to which 600 yards were added since 1865.

Work done, and Mode of doing it.—The rate during a day of 10 hours, including removals (which average 2 hours each, with 2 horses), is—

Subsoiling, 16 inches deep	.. .. ..	2½ acres.
Ploughing, 9 „	.. .. ..	5 „
Cultivating, 6·7 „	.. .. ..	10 „

There were 123 acres subsoiled before the Christmas of 1865 and 15 ploughed; during the spring and summer of 1866, 114 acres were subsoiled and 176 cultivated. Between the harvest of 1865 and that of 1866, 105 days' work were accomplished. In this period, however, there were 210 over hours paid for beyond the 10 constituting the ordinary day's labour. The apparatus is not much used in the Park Farm on account of

the clumps of trees standing in the midst of the fields. Here and there it has, however, been employed, and generally with the best results to drained land. One field was fetched up to a great depth with the digging breasts, so that the red gravelly subsoil was admixed with the staple, and so increased its fertility, that the barley, wheat, and clover crops have never since forgotten it.

Cost of Work.

	£.	s.	d.
Manual and Horse-labour per day:—			
Engine-driver	0	2	6
Ploughman	0	2	0
3 porter-boys	0	3	0
1 anchor-boy	0	1	6
Water-cart, boy and horse	0	4	6
	0	13	6
Average labour payment extra	0	4	2
Coal	0	5	10
Oil	0	1	0
	1	4	6

N.B.—Men paid by the day with the following extra allowance per acre divided between the driver and ploughman equally:—for subsoiling, 1*s.* 8*d.*; ploughing, 10*d.*; scarifying, 5*d.* *Coal*—"Gawber Hall," a hard coal, 17*s.* a ton, home; consumption, 7 cwts. per day of 10 hours = 5*s.* 10*d.*

The smith's work is done on the estate.

We were received with great kindness by Mr. Shellabear, his Lordship's steward.

No. 4. Mr. S. Linton, Long Stanton, Cambridgeshire, September 12.—Mr. Linton has the advantage of farming his own land. The farm, which consists of 500 acres, is generally heavy. The arable land, about 400 acres, is ploughed by 3 horses 5 to 6 inches deep with some difficulty. There are about 100 acres of a gravelly clay loam which will grow turnips. The farm has been drained from 30 to 32 inches deep, 1½ rods apart. The fields, small in area, were thrown into high back lands when the farm was bought; they have since been enlarged and the lands thrown down; but owing to some difficulty in getting off the water, there is a disposition to return to ridge and furrow. The outfall it seems will not allow of deeper drains, but we were led to think that a little stroke of engineering would relieve the land of that which defeats the owner's present intentions. The fields are now from 12 to 90 acres in extent. The supply of water is plentiful. That which is drawn from the wells that have been sunk is not so good as that which is obtained from ponds. The number of horses has been reduced from 15 to 12, which is to 2 horses to each 66 acres. The situation

of the farm is such as to require more than usual horse-power. Ten carts are kept going in harvest, and the extra horses are wanted for the corn-mowing machine. Fallows, which were the rule, have been abandoned. The course of husbandry has been beans, wheat, varied with clover. Mr. Linton intends to grow wheat every other year on the same land. The beans and wheat system will have to fight with weeds, which may be kept down by steam power, provided the present signs of a water-logged farm are got rid of; but they certainly could not be by the application of horse-power under any circumstances, or by steam power unless the land is laid dry.

Mr. Linton could say little about increased crops. We were induced to think that deeper culture, rendered possible by deeper drainage, would allow of the production of roots to much larger extent, and possibly—inasmuch as this has been accomplished on land as heavy—the feeding of sheep.

The *Apparatus*, Fowler's patent, was made in 1862 by Burrell. It consists of an engine of 14-horse power, double cylinder, an anchor, cultivator, rope-porters, 800 yards of rope; price 875*l.*

The engine does all the thrashing, chaff-cutting, and grinding of the farm.

Repairs, Renewals, Wear and Tear.—No regular account kept. The engine is said to have required nothing except the drawing of the tubes. The greatest wear is reported to have been on the implements. The first rope was replaced without charge by a second, which has worn well and is in a very good state.

Work done.—During a day of 10 hours, including removals, 8 to 9 acres with cultivator. In the autumn of 1865, 237 acres were broken up once, 8 to 9 inches deep. 50 acres have been done during the spring of 1866.

Cost of Work.

	£.	s.	d.
Manual and Horse-labour:—			
Engine-driver	0	3	0
Ploughman	0	3	0
3 anchor and porter-boys	0	4	6
1 boy and horse	0	5	0
	0	15	6
Coal	0	9	3
Oil	0	2	0
	1	6	9

N.B.—Men paid only by the day; paid for overtime in same proportion. Coal "Hard," 15*s.* 6*d.* per ton home; consumption, 12 cwts. per day.

We saw the apparatus, but not at work. Mr. Linton was kind enough to point out several ingenious improvements of his own. Amongst others may be noticed the wrought-iron cultivator-prong and share shown at P, and the method of setting the slack gear in motion independent of the steersman's weight.

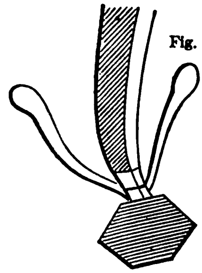


Fig. P.

No. 5. Mr. Barton, Woodhurst, St. Ives, Huntingdonshire. Sept. 13.—Mr. Barton is a good specimen of a thoroughly practical man, who though not given to change or to new-fangled notions, embraced steam because he saw in it the means of working a heavy-land farm to advantage. He is a cowkeeper, provides the London market with milk, so that it is a matter of importance to have abundance of green cropping. The land belongs to Mr. F. Annesley. It consists of 700 acres, 500 of which are arable-land of so stiff a texture that sometimes 6 horses are required to plough 6 inches deep. The under-drainage was commenced before steam was introduced. Half the farm is drained 4 feet deep. Experience has established the great worth of deep drainage followed up by deep cultivation. A great deal of the land is now ploughed on the flat. The subsoil is a gaulty clay. The average size of fields is 30 acres. The hedge-rows, which are kept low, are tolerably straight. The fields are undulating and devoid of timber. The 4-course system of cropping is observed: 1st.—Wheat. 2nd.—Turnip-seed, tares, or peas. 3rd.—Barley, oats, and part wheat. 4th.—Two-thirds seeds and one-third beans.

Red clover is taken once in 12 years. Dead fallows were dispensed with when steam was called in; all now is in cropping. The land was formerly tilled by 27 horses, or 2 horses to 58 acres; 20 are now kept. The water is good and abundant, save in dry weather, when it has to be fetched 2 miles. It is obtained from storage ponds supplied by drainage.

The *Apparatus* was mainly bought of Messrs. Howard in 1862. It consists of an engine of 10-horse power, made by Messrs. Hornsby, and valued at 280*l.* They received in exchange for it an 8-horse power engine of their own make, and allowed 65*l.* for the old engine.

	£.
The other members were a cultivator, windlass, 1400 yards of rope, &c.:—Price	200
Extras	20
	220

Repairs, Renewals, Wear and Tear.—The repairs of the engine

are estimated at 30*l.* a year, of which only one-half is charged to cultivation, the engine being otherwise employed. The repairs are greatest on the rope and the snatch-blocks. In 1864, 800 yards of fresh rope were obtained of excellent quality, and last spring 800 yards more.

Work done, and Mode of Working.—During day of 10 hours, first time over with 3 tines, removals included, 7 acres; with 5 tines 10 acres, 6 inches being about the greatest depth—"quite deep enough." The steam pressure averages 53 lbs.; the removals take 6 horses 4 hours. Notwithstanding the continuous rain since harvest, we found during our walk across the farm that fully 180 acres had been broken up after the crop. A considerable portion of this had grown turnip-seed, and the apparatus was engaged upon it all the harvest. We visited no farm on which the tackle had been so efficiently used during the preceding 3 months. The land so treated was lying in a fine rough state, and, like the reedy stubble, presented a very clean face. The engine was working when we saw it, and the tackle, with the exception of the cultivator, which was weak and strained, was in a fair state. Mr. Barton uses two snatch-blocks and anchors on each headland, and was about the first to do so. By this means he avoids stoppages. He has also introduced two small wheels in the framework of the snatch-block to facilitate its transport. To prepare for roots, the wheat-stubble is broken up by steam in the autumn, then manured and ploughed with horses. The remaining operations depend upon the state of the weather. A plough is "much wanted," so that the engine may be at work when the cultivator cannot be used.

Cost of Work.—This is estimated by Mr. Barton at 6*s.* an acre, besides interest and depreciation; of this sum rope costs 1*s.*, and "other repairs" 1*s.* per acre. An average year's work is about 400 acres of tillage. The first rope was bad, and cost 1*s.* 6*d.* per acre. The manual and horse labour costs—

	£.	*s.*	*d.*
Engine-man	0	3	0
Windlass-man	0	3	0
Ploughman	0	1	2
2 anchor-men	0	3	4
3 boys	0	2	2
Water-cart, boy and horse	0	3	2
	0	15	10
Oil	0	1	0
Coal	0	8	6
	1	5	4

N.B.—The men work now by the day. The first 2 years they worked by the piece, 2*s.* 6*d.* an acre divided amongst them, but they could not agree. Consumption of coal, per day of 10 hours, 10 cwts. = 7*s.* 3½*d.*

Mr. Barton thinks that the possession of 300 acres of such land as he farms would justify a man in attempting the use of steam. The horses he sold gave him more than 100*l.* towards his apparatus. Something more might be realised by the sale of implements displaced. He uses carts for harvest, and does not need more than 8 to secure it. The corn is stacked in the field. The live stock kept the year round consists of 500 head of sheep and 75 to 100 dairy cows.

No. 6. The Duke of Manchester, Kimbolton, Hunts, Sept. 14. This farm consists of 700 acres—210 arable, 490 pasture. Our time was unfortunately too limited to allow of a visit to the farm, which is some distance from the steward's office. At Kimbolton station, 3 miles distant from the Castle, there was no vehicle to be had to convey us, so that the time that we should have passed upon the farm we were obliged to spend in walking to it. The staple is a loam, the subsoil a loose and soapy clay containing chalk-stones. It is under-drained 3 feet deep, from 8 to 11 yards apart. The depth of the drain now being cut is 4 feet. The high ridges are gradually melting into the furrows, and the fields are fast being worked on the flat. The land is such as requires three horses to plough 3½ roods a day 6 inches deep. Great improvement has been made in the size and figure of fields. The farm was partly taken out from forest land twenty or thirty years ago. The fields were then from 3 to 12 acres. They now average 25 acres; the hedgerows are being straightened and divested of timber. His Grace, in thus remodelling his own farm, affords an earnest of what he is willing to allow, and anxious to see effected around him. He is beloved by his tenantry for his exceptional liberality. Anything like stringent covenants are unheard of. The tenants are chosen for their reputation as farmers, and then trusted to farm as they please, his Grace being quite convinced, that "if they farm for themselves, they will farm for him." A chivalric attachment to their landlord consequently runs through the tenantry, in proof of which stands prominently out the dashing regiment of volunteer cavalry in which they are proud to find a place. This feeling is nourished by various acts of considerateness; for instance, the Duke has allowed his steam-tackle to go out now and then to break up a stubborn lot of land for a tenant with rather stubborn prejudices, and generally the result has been to educe a voluntary application for the tackle the following year. The 5-course of cropping used to be adopted; the roots consumed partly off, partly on the land, but has given way since the introduction of steam to a course of 8 shifts—roots, oats, beans, wheat, clover, oats, beans, wheat. Clover could not be grown before deep tillage by steam. None of the land can be trodden with sheep

in the winter; 25 acres of clover and 25 acres of roots are taken year by year, the clover-hay being consumed with the roots. The supply of water is plentiful, and the water good. When the steam-share or tine has well shattered the subsoil to a depth of 15 inches from the surface, the drainage is perceptibly improved. The texture of the land, too, is so changed that roots can now be grown where no roots were grown before, and half the root-crop is now fed on the land up to January 1st, after which the sheep are removed.

The *Apparatus*, bought in April, 1859, from Mr. Smith, consists of the two cultivators, windlass, rope, &c., price 200*l.*, to which has been added a home-made 7-tine cultivator; the previous engine of 7-horse power, bought in 1851, was exchanged 1863 for the present 10-horse power double-cylinder engine, valued at 300*l.*, and made by Clayton and Shuttleworth, who allowed 50*l.* for the old one. The engine is employed nine months in the year thrashing, grinding, and sawing timber for the estate.

Repairs, Renewals, Wear and Tear.—The original rope, of 1400 yards, has been supplemented by 1000 yards; 800 yards have been used up, and 1600 yards are therefore left, which are calculated to last two years longer. The old anchors and porters have been replaced by new and improved ones. The farm-bailiff, Mr. Wallis, estimates these expenses at 1*l.* per working day. He considers the repairs are less than in doing the same work with horses. A smith employed on the premises does the repairs. The breakages are principally caused by the tree-roots.

Work done, and Mode of doing it.—The first operation, 5 acres per day, 12 inches deep; the second, 8 acres, 8 inches deep, removals being included in both cases.

The following Table shows the number of days' work in each year. The average work per day is 6 acres:—

Year.	Days.	Acres.
1859	31	186
1860	45	270
1861	57	342
1862	59	345
1863 (new engine)	47	282
1864	47	282
1865	56	336

N.B.—A much larger amount of work would have been done had the apparatus comprised a plough, which is "much wanted."

Cost of Work.—Formerly the work used to done by the day. Piece-work is esteemed much better. His Grace finds coal,

water, horses for removal and one for water-cart. The work is let to the engine-driver (who was formerly a team-driver), the windlass-man, and the ploughman, who are paid 3*s.* an acre first time over, 2*s.* the second time over. The men find all manual labour, even for removals. In harvest-time they receive 1*s.* extra. The general rate of wages in the district is from 11*s.* to 12*s.*

The coal used, "Derby Hards," price 16*s.* a ton home; consumption, 10 cwts. per day of 10 hours. These items thrown together shows the cost of a day's work to be—

	£.	s.	d.
6½ acres at 2*s.* 6*d.* (average)	0	16	3
Boy, horses, water-cart	0	5	0
Coal, 10 cwts.	0	8	0
Oil..	0	0	9
Wear and tear and interest..	1	0	0
	2	10	0

The last item Mr. Wallis, in a subsequent communication, "considers excessive," resting his opinion in part on the fact that the engine does three times as much of other work as of cultivating.

The horses are reduced by two. Six are now kept for the farm (two to 70 acres) and six for the estate. Those now remaining have much easier work. Eight of the number are mares, which produce four or five foals; they are turned off at foaling-time, and taken up for harvest.

In comparing horse-labour with steam in the case of deep work, where many horses have to work together, there is no doubt about the advantage of the latter. The Marquess of Tweeddale's great plough, worked with twelve horses, got over about half an acre a day. The 7-horse power engine did 3 acres at the same depth with 50 to 60 lbs. steam-pressure.

Mr. Wallis considers that farms of 400 acres would pay for steam-tackle. His experience at Kimbolton shows that not only is the yield of corn increased 4 bushels per acre, but that its market value is increased 2*s.* a quarter. The staple is deeper and better mixed with subsoil, and produces a straw stout and upstanding. The root-crops are also better. Work is not only done with greater dispatch, but with greater certainty. It was once difficult to say when four teams would finish a 20-acre field; but with steam the time of finishing can be stated within an hour. All correlative work is quickened, and the men had rather work with the tackle than with horses.

The objections urged against the use of steam in this neighbourhood are mainly four in number: 1st, outlay of capital; 2nd, the impossibility of reducing the number of horses; 3rd,

the smallness of enclosures; and 4th, the abundance of timber. As to the third and fourth objections, we refer to the report of Mr. Prout's estate improvements, which show the gain that would result to the landlord were he able and willing to remove the obstacles that now impede the use of the steam-plough. The second objection arises, in our opinion, out of an erroneous mode of looking at the question, as we have shown elsewhere.

No. 7. Mr. George Armstrong, Graffham, St. Neots, September 14. This farm, occupied by a spirited young man, come of a race of practical farmers, lies a few miles from Kimbolton, and is a portion of the Duke of Manchester's estate. It consists of two homesteads and 750 acres, 170 acres being grass. Mr. Armstrong has held it fourteen years. The soil may be termed a hungry clay on a clay subsoil, difficult and expensive to work, and enough to ruin any man who did not employ steam. The farm extends over an undulating hilly district, the buildings being at one corner of it. The hedges are low, divested of timber; and the fields, well supplied with good pond-water for the engine, have been enlarged for steam, and now vary from 12 to 50 acres. The land is under-drained 3 feet deep, the drains being from 5 to 8 yards apart. The 4-course system cropping prevailing before the introduction of steam—namely, 1, dead fallow; 2, barley; 3, seeds or beans; 4, wheat—has given way to a 5-course, barley being introduced after wheat, and roots substituted for dead fallow. The yield by this means is very much increased. The yield of wheat is now from 4½ to 5 quarters, and roots can be fed on land which aforetime would not produce them. The land used to support 250 ewes; we found there 700 sheep; the stock of sheep, the year round, is 500. In place of 25 horses, there are now 16, or 2 to 72 acres, which is still a somewhat high proportion. But four of these are mares breeding every year; and all are kept fresher and better at less cost. They used to have 1 peck of corn a day: "From May to September this year they had no corn at all." It may be affirmed that half the corn-bill for the remaining sixteen is saved. Carts are used in harvest. Mr. Armstrong feels assured that he could not have stood his ground on this farm without steam. We were very much pleased with the appearance of the farm. The abandonment of dead fallow, and the quick succession of crops, which might have favoured weeds, has not been allowed to do so.

The *Apparatus* was bought of Mr. Smith in 1858. It consists of one 3 and one 5-tined cultivator, 1400 yards of rope, windlass, porters, extras, &c., 220*l.*; an engine of 8-horse power, double cylinder, manufactured by Clayton and Shuttleworth, 250*l.*

The Work done, and Mode of working.—First time over from

4 to 6 inches deep, including removals, about 6 acres; and 8 acres the second time over, the same depth. About 200 acres of ground are broken up every year, and much of it is twice done. The apparatus is almost exclusively used in the autumn. Mr. Armstrong does not care about it before. "The moment after the corn is off we begin; work all harvest from 5 o'clock till 8 P.M." Eighty acres were done since harvest, in spite of wet. The steam-pressure is seldom above 70 lbs. The mode of preparing for roots is as follows: the wheat-stubble having been manured is broken up at two operations in autumn, and in spring it is stirred once or twice. If Mr. King's experience were available here, one autumn operation would suffice.

Cost of Work.

	£.	s.	d.	
Manual and horse labour per day:—				
Engine-driver	0	3	0	
5 men, 2*s.*	0	10	0	
1 boy and horse	0	5	0	
	0	18	0	
Coal	0	8	3	
Oil	0	1	0	
Total	1	7	3	= 3*s.* 10¾*d.* per acre.

N.B.—3*d.* an hour is paid for all hours beyond 10½.

Mr. Armstrong's estimate of the cost of cultivating an acre stands thus, interest being charged on three-fifths of the cost of the engine, and on all the tackle, and 400 acres being taken as a year's work:—

	s.	d.
Depreciation 10 per cent. on 370*l.* divided over 400 acres ..	1	10
Interest 5 per cent.	0	11
Repairs of engine and apparatus (30*l.*)	1	6
Maintenance of rope	1	8
	5	11
Labour, coals, and oil	3	10¾
Total cost per acre	9	9¾

Five ropes have been bought in all, the two first iron, the rest steel; the last, bought in 1866, is expected to last till 1868.

Breakages mostly occur in snatch-blocks. The tackle is in a good state. It has been let out, but has been so badly treated that it is never to go again off the farm. The second year about 300 acres of contract-work was done, the two operations for 1*l.* an acre. The price was then raised to 1*l.* 10*s.*

Mr. Topham, a near relative to Mr. Armstrong, occupying an

adjoining farm cultivated by steam, informed us that he worked by the piece, and paid 2*s.* 6*d.* per acre for 3-tine, and 1*s.* 6*d.* for the 5-tine scarifier, including all expense incurred in removals, save the horse-power required.

The coal used is termed "Hucknal Hard," price 14*s.* per ton at home; consumption, 12 cwts. per day of 10½ hours.

No. 8. Mr. Cranfield, Buckden, Hunts, September 17th. This fine farm of 1000 acres has not long been rescued by the Ecclesiastical Commissioners from the dominion of wood, scrub, and weed. Under their hands it was drained 4 feet deep 10 yards apart, bisected by a good main road, laid out in square fields, a new house and homesteads were built, and all was placed in the keeping of a spirited and intelligent man. The property then passed into the possession of the Bishop of Peterborough. Fully 600 acres of the land is stiff and loamy—what is termed "woodland," with clay subsoil, intermixed with chalk stones. Three horses plough an acre, 6 inches deep, in 10 hours. The remaining 250 acres are easily ploughed with a pair of horses. The water is good. Part of the land drains into a large reservoir, and 5 wells have been sunk to supplement the natural pond-supply. Mr. Cranfield, although he sees no benefit from Steam Cultivation to drainage, confesses that he grows roots on land that never produced them formerly, and feeds them off too. He grows 150 acres of roots, and has never lost a crop on this stiff land since he has employed steam. That double the corn is grown, compared with the produce of the same area a few years ago, is not a result that can be attributed entirely to steam—the large head of stock, averaging 1000 sheep and 200 beasts, has something to do with it—and the expenditure of about 3000*l.* per annum in cake, corn, and artificial manure, is not an item that can be omitted from the calculation. The work on this farm is said to be never in arrear, "nothing is left to be done in the spring." The 4-course system of cropping is generally observed in the district. Mr. Cranfield is impatient of this restriction, it being his opinion that those who have enterprise to farm up to the spirit of the time, making large outlay in artificial manures, feeding stuffs, and machinery, should farm with unshackled hands. It is not to be supposed, he says, that a man will lay down money in this manner if he is prevented from doing as he likes. "One hundred acres of my land is in roots, one hundred and sixty in seeds, and the rest is corn. Putting what I do into the land I must and will farm as I please." He considers that a yearly tenancy and the 4-course system are antagonistic to steam culture. If the land becomes too strong to grow crops that will stand, some change of rotation must be introduced to tame it. Where a head

of stock as large as that of Mr. Cranfield is kept, the land must be in such a high condition as to render 2 white straws in succession the only safe course to be followed. The size of the farm was at first 570 acres; horses were kept; on the addition of the steam tackle 175 acres were bought, and still another 50 acres were subsequently put to the farm without adding to the horse power. A little later 204 acres were united to the foregoing, and 4 horses more were found necessary. Mr. Cranfield notes no difference in feeding or in work, does a great deal of scuffling with horses, which is heavy work. Harvest, he says, he could get through with 20 horses—he carries his crops on carts.

The *Apparatus* was bought of Mr. Smith, in 1858, at the Chester Meeting.

The engine of 10-horse power, double cylinder, portable, was made by Butlin, and bought in 1861. The first engine of 8-horse power was worked 3 years, and with the addition of 100*l.* was then exchanged for the present one. The cultivator, windlass, rope, and porters, were bought second-hand for 160*l.*

Repairs, Renewals, Wear and Tear.—There have been 4 ropes. The first 2 were defective. The 4th is the best, it has lasted 2 seasons. The engine was repaired in March last, the tubes only were drawn, and the boiler patched. The cost is about 10*l.* a year, the half of which must be debited to thrashing, grinding, &c. The total wear and tear, exclusive of interest, upon the entire apparatus, is 4*s.* 6*d.* per acre.

Work done and Mode of doing it.—The first operation, 8 to 9 inches deep, removals included, 6 acres per day. About 230 acres (1st operation) are broken up by steam every year. This work is done in and after harvest. The preparation for roots is as follows:—the stubbles, having been manured, are broken up at one operation, 8 to 9 inches deep, in the autumn. When spring comes horses do the cross cultivation. The roots are generally grown with 2½ cwts. of superphosphate and 1 of guano, but of no dung. The drill is used to put in wheat after beans, and barley after roots. Mr. Cranfield does not play with his apparatus. He uses it to break the neck of his work. He contents himself with doing merely the first operation, and leaves the second to be done by horses, under the strong conviction that they do this work much cheaper. The cross cultivation is invariably done by horse power. To work the farm as he now does he would require 40 horses if unaided by steam. Were one-fourth of the farm a dead fallow every year, he would keep fewer horses; but the fact is that he does much more than he did. The drill (Smith's) works admirably.

Cost of Work.

Manual and horse labour :—	£.	s.	d.
1 engine-man	0	2	10
Ploughman	0	2	4
4 anchor-men	0	8	0
1 boy and horse	0	5	0
	0	18	2
Coal	0	13	0
Oil..	0	2	0
	1	13	2

N.B.—The daily wage in the neighbourhood is 1*s.* 10*d.* Coal—"Hucknal Hard," 16*s.* per ton; consumption, 16 cwts. per day of 10 hours.

He considers that he has quite enough land to employ a set of tackle fully. Were he to hire another farm he should certainly purchase another set. He thinks 400 acres of arable land sufficient to justify such a purchase. We found the tackle at work. Like the entire farm, it gave indications of being in careful hands.

No. 9. Mr. E. Roberts, Berden Hall, near Bishop Stortford, Essex, September 19, 1866. This is again a good farm, on which steam cultivation appears to advantage. Things are well done, and farming is carried on for profit and to profit. In all there are 750 acres, 70 acres being pasture. Of the arable portion, 500 acres are such that 3 horses will barely plough an acre 5 inches deep. The land rests on the chalk. Over a large portion of this is stretched a layer of blue and white clay, and over this, with various depth and incline, lies a loamy staple, more or less partaking of the character of the stiff subsoil. This subsoil, being retentive of water, requires drainage, and has been drained to a depth of 30 inches, the drains being 17 to 18 feet apart. Mr. Roberts considers that the results of steam are very perceptible in improved drainage. One part of the farm, about 250 acres, called the Potash Farm, belongs to Mr. Robert Gosling, well known in the financial world. Five hundred acres, called the Hall Farm, belong to Christ's Hospital. Mr. Roberts entered into occupation in 1852; he has since reclaimed 80 acres of woodland, at the expense to the landlord of about 20*l.* per acre.

The labour account amounts annually to 1100*l.*; the rent to 1000*l.*; tithes nearly 200*l.*; and rates about 150*l.*

The heavy land is farmed thus :—wheat, oats or barley, seeds, wheat, beans.

The favourite rotation for the heavy land used to be wheat and beans alternately, with an occasional plain fallow. Since

the steam-plough has been used the summer fallow has been abandoned. The Potash Farm, which is most of it light land, is cropped upon the 4-course system.

Mr. Roberts states that he has been able to dispense with 8 horses; the number now kept being 14, which is equal to 2 horses to 96 acres. These remaining horses have been lightly worked, kept in better condition, and at less expense. The farm labour is also more advanced, and kept to the season. When the wheat sowing is going on the steam-plough is stirring the land intended for green crops. The work is better done, and the soil lies drier during the winter, is ready early in spring for seeding, and is surer of producing a root-crop. Of the crops generally, he remarks that they are increased; also that the use of improved machinery necessitates the employment of more manual labour, and that of a superior quality. The water supply is plentiful and good. The fields have been much enlarged: they are now from 10 to 120 acres. The example here set may induce neighbouring landlords to give some encouragement to steam cultivation, or at least to allow some fences to be grubbed up.

The Apparatus was bought of Messrs. Fowler in the autumn of 1860. The *engine* was one of the first six made by Kitson and Hewetson of Leeds. It is of 10-horse power, double cylinder, traction. A 4-furrow plough, 7-tine cultivator, 800 yards of rope, anchors and rope-porters, completed the set, at a cost of 780*l.*

Repairs, Renewals, Wear and Tear.—Mr. Roberts kindly furnished us with the following ample details, by which it will be seen, that while the repairs have been heavy, much of the outlay has been due to the substitution of improvements which have followed closely one upon another.

	£.	*s.*	*d.*
1860.—First outlay for engine, plough, anchor ropes, and porters	747	0	0
Carriage of ditto	27	2	6
Man to instruct my own people	6	0	0
	780	2	6
1861.—500 yards of rope	32	5	0
New plough	97	0	0
New clip-drum	26	10	0
Carriage of new plough and clip-drum gear ..	7	4	8
Men's time and expenses from Leeds	30	13	6
7 dozen shares	4	18	0
Slades, breasts, skifes, &c.	3	18	0
	202	9	2

	£.	s.	d.
1862.—Carriage of anchor	4	5	6
200 yards of rope	23	2	0
Changing anchor for full-sized one	15	0	0
Sundries	5	8	0
	47	15	6
1863.—New cultivator, with extras	86	2	8
Carriage of ditto	4	6	2
Ditto of other irons	2	19	0
Widening wheels and adding steerage	25	10	0
Pair of plough wheels	7	0	0
50 yards headland rope	3	5	0
250 yards steel rope	25	5	0
New clip-drum	15	0	0
New steam-gauge	3	10	0
Sundry irons for engine and plough, and labour of man from Leeds	43	10	7
	216		
1864.—500 yards steel rope	52		
Press pulleys for clip-drum			
New pump			
Skifes, and other parts for plough			
Labour by men from Leeds repairing pump and other breakages			
Carriage of irons			
1865.—New axle to hind-wheels of engine			
Sundries			
Ash-pan to engine			
Plough-irons			
Sundries for engine ..			
Shares and points ..			
Labour from Leeds, also			

1860.—First
1861
1862
1863
1864
1865

Work
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For roots, the stubble is broken up in the autumn in the frost, ploughed by horses in the spring. If th permits, the land is deeply crossed and recrossed by s is horse-ploughed with a very shallow furrow, to for seed-bed; the turnips are then drilled on the flat, wit of superphosphate.

Cost of Work.

Man ... labour: av ... wage, 1s. 8d.:—

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foul with root weeds, and so out of

that the farewell wheat-crop of one outgoing tenant is declared not to have exceeded 12 to 16 bushels per acre. Drainage, of course, was the fundamental process in the amelioration. . . . .

"The two holdings in one ring-fence numbered no fewer than 51 inclosures, averaging not quite 9 acres each; and what with meandering watercourses, and straggling fences of a wildly picturesque description, those innumerable boundaries were awkward for cultivation, wasteful of ground, injurious to cropping, and costly to keep in repair. By exchanges of plots with neighbouring owners, the outside fence was made rectilinear and symmetrical; the bill, mattock, and spade, attacked the formidable net-work of internal ('infernal' our note-book seems to have written it) hedges; the axe brought down the pride of scattered timber; and the spade, pick, and earth-cart straightened watercourses, filled up old channels, and excavated clean-cut, direct, deep outfalls instead; while five straight new roads were struck across the old medley of inclosures, dividing the whole farm into seven spacious plots of a generally quadrilateral figure. The work is now complete; and Mr. Prout having kindly opened his bailiff's books to our inspection, we are enabled to state how much has been the cost of the whole. Of bushy hedge-row, a length of 514 chains (that is, nearly 6½ miles) was stocked, and the ditches alongside levelled in for an outlay of 155*l.* 12*s.* Now, observe how immediate is the profit to Mr. Prout as owner of the soil. The abolished fences having averaged 7 yards in breadth (measuring between the extreme limits of the plough on both sides), an addition has been made to the estate of no less than 16 acres, now lying in strips in all directions across the large fields, open to every operation of good tillage and manuring. The cost price of the land in 1861 was 35*l.* per acre, every item of expense included; and therefore the 16 acres gained represent a value of 560*l.* The hedge-roots were given to the labourers; the brushwood was either buried in drains or used for burning; but the 920 trees, consisting of pollards and inferior timber, came in for gates, gateposts, and other stuff, estimated as worth altogether about 42*l.* Here, then, we have a present return of no less than 602*l.* for an expenditure of 155*l.* 12*s.* during four years. . . .

"This reclamation of waste ground by the simple demolition of useless fences, forms a striking example of safe and quick profit upon an easy outlay, sure to be imitated (one would think) over tens of thousands of acres. The earthwork of filling up old watercourses, cutting 130 chains' length of new ones, and levelling in a few moats, ponds, and waste places, cost 155*l.* 12*s.*, reckoning 8*s.* per day for a pair of horses engaged in carting. The a[illegible] of ground thus acquired is about 2½ acres, which, at

35*l.* an acre, leaves an outlay of 68*l.* 3*s.* as the cost of the improved outfalls for the drainage of the whole farm. . . . The total outlay in four years was 311*l.* 5*s.*, and the return—18½ acres of land at 35*l.*—647*l.* 10*s.*; add the wood, 42*l.*, making a total of 689*l.* 10*s.* The expense of the new grass headland paths for the steam-ploughing engines does not materially alter these figures, for while 62 chains' length of new grass road has been laid down, 74 chains' length of old road has been ploughed up and added to the arable ground.

"This farm, once so foul, has been brought in four years into the cleanly condition of a well-kept garden, and during the last two years the whole has been ploughed and subsoiled 14 to 16 inches deep. When we visited it last November, the whole of this year's wheat seeding (223 acres) was finished, all the land for spring corn lay ready ploughed, and the land for roots was in the same forward state, requiring only the harrow and drill when sowing time should come, so that no heavy tillage of any description remained to be done until after the present harvest; and the perplexity of the manager was not, 'How shall I be able to get through the spring and summer work due to a large arable clay farm?' but, 'What new labour can I find to employ my men throughout the winter and spring?' The former occupiers are reported to have kept a score of horses at work in tilling but 5 inches deep. Mr. Prout has done all his work with 10 horses and a 14-horse-power Fowler engine; and having entirely completed the reclamation, his intention is to reduce his force of horse-flesh to only five good animals, which will suffice to cart the corn into ricks beside the field roads; they can manage this, because 8 horses led the last harvest up to the homestead. The amazing reduction in tillage expenditure from having a thoroughly clean farm, further appears from the fact that, in future, the engine, too, will have an easy time of it, as all its work will occupy only about a couple of months during the entire year.

"That Mr. Prout has not spent a fortune in eradicating weeds and breaking up the soil to its present great depth of staple, is proved by the labour-book. The cost of hand-labour, including the wages of the steam-plough hands, the labour of stocking hedges, and of all the drainage, was for the first year 726*l.*, for the second 1142*l.*, the next 1020*l.*, and for 1865 up to the present time, 880*l.* The ordinary expense of 10 horses need not be stated in figures; but it is necessary to say what was the total cost of working the steam-plough. The hand-labour is included in the above amounts; the water-cart horse was one of the ten, and is now one of the five. The coals, at 16*s.* to 17*s.* per ton, cost in 1861-2, 114*l.*; in 1863, 86*l.*; in 1864-5, 165*l.*: altogether, 365*l.* Oil, &c., cost 34*l.* in the 4 years. Repairs

and the addition of improvements in the machinery cost 180*l.* in the 4 years. Interest and depreciation on 994*l.*, the prime cost of the apparatus, inclusive of rope, say at 12½ per cent. per annum, came to 476*l.* in the 4 years. Then we have the item of wire-rope worn out. The original 800 yards cost 84*l.*; 450 yards, added in two years' time, cost 47*l.* 5*s.*; and from personal inspection of this 1250 yards, we estimate the present value at one-third, or 43*l.* 15*s.*; thus leaving 87*l.* 10*s.* as the total expense of rope consumed during the 4 years. The entire outlay for steam work then (besides the manual labour already included in the general account) is 1142*l.* 10*s.* in the 4 years.

"Ten horses, in place of the engine, would have cost about the same; but they would have made up only the old force of 20 horses, that kept the staple shallow and the crops foul. Twenty horses, in lieu of the engine, would have cost double the money; but even if they could have cleaned the farm, it was utterly beyond their ability to deepen the 5-inch staple to treble its depth, and accomplish a light crumbly style of tillage, such as now enables the corn to be sown early in a pulverulent seed-bed, and green crops to grow where dead fallow reigned before.

"That the steam-tillage has developed inherent fertility in the soil, appears from the fact that almost all the white-straw crop of 1864, and most of the roots too, together with 536 quarters of wheat, and about 300 tons of the straw of 1863, were sold off the farm. The sale took place by public auction; and the excellent character of the yield may be judged of from the prices made. Thus 147 acres of wheat, with the straw as staked out upon the land, sold for an average of 9*l.* 1*s.* per acre; 73 acres of barley, with the straw, sold for an average of 7*l.* 19*s.* per acre; and 29 acres of oats sold for an average of 6*l.* 11*s.* per acre.

"It is certainly not high manuring that has produced the good crops; for Mr. Prout has not applied more than 640*l.* worth of any purchased manure during the whole four years. And that a consumption of sheep and cattle food has had little share in the business, is evident from the circumstance that, in 1863, Mr. Prout fattened only 58 oxen; in 1864 he kept only a single cow; and he never has farmed until the present season either a sheep or pig. The horses kept numbered but eight, as two of the ten previously stated to have been employed represent the average of teams hired. The head of stock on the farms in November consisted of 14 bullocks feeding in barns and houses, 1 cow and calf, and 8 horses.

"Dr. Voelcker's analysis shows the soil to possess a practically inexhaustible fund of fertility, though apparently of very ordinary quality, like vast areas of similar land in Great Britain; and Mr. Prout might probably pursue with advantage a garden

management almost independent of rotations, live-stock, and manuring. But his intended husbandry will prudently embrace the sheep-feeding of a portion of the root-crop, with probably a purchase of stable-manure from London in return for straw sold off. This is one of the most surprising examples yet seen of the virtue of deep steam-tillage on a heavy soil, hitherto suffered to lie semi-utilised under a miserable, yet costly system of shallow culture by draft animals. But the immediate lesson from the case is the certainty of profit to landowners from clearing away those vermin-filled banks and bird-infested scrub fences, which are now choking up thousands of fine farms, and obstructing the progress of the fructifying steam-drawn share."

To this account, which our observations and enquiries completely confirm, there are a few facts to add. The land is so stiff as to require three horses to plough 1 acre 5 inches deep. It is drained 3½ feet deep, 10 to 11 yards apart, and is all laid flat. The hedgerows are all cleared away, and the open space is divided into blocks by five engine-roads—a main centre-road of gravel and four grass-roads—from which every bit of land can be cultivated. The cost of this clearance is seen from Mr. Clarke's sketch. The supply of water is mainly from two wells: other wells have been sunk at different points along the road, for the supply of the engine. The water leaves a chalky deposit, and necessitates the cleaning of the engine every fourteen days. It is difficult to say anything respecting the former course of husbandry, save that it brought but little grist to the mill. The present rotation of crops is trefoil fed off, oats, wheat, fallow (tares), wheat. This rotation has been followed since 1861, without manure, not even a flock of sheep, yet with increasing crops. All the land is under crop, be it observed, except a little where seeds grow; the crops, roots, hay and all, straw included, are sold off. The stock is confined to eight horses and a few pigs. That the crops appear to increase is due to the fact that every fresh inch downwards opens to the penetrating rootlets fresh sources of fertility. This is a case of a grateful subsoil, whose resources have never before been drawn upon.

At the last sale, which occurred immediately before harvest, 223 acres of wheat, 124 of barley, and 60 of oats had been sold as they stood for 3400*l*., to be harvested at the cost of the purchaser.

The *Apparatus* was bought, October, 1861, of Messrs. Fowler. The *engine*, made by Kitson and Hewetson, is of 14-horse power, double cylinder, traction, and is used also to thrash; one 4-furrow plough, a 2-furrow subsoil plough, 7-tine cultivator, 800 yards of rope, a self-moving anchor, 20 rope-porters, and water-cart; price 1065*l*.

Repairs, Renewals, Wear and Tear.—Rope, since 1861, 780

yards; cost of rope per annum, 22*l.* The heaviest repairs are on the 2 clip-drums. No exact account of repairs could be given; but we were led to believe that the whole annual expense, over a period of eight years, would not be more than 50*l.*

Work done, and Mode of doing it.—The following Table will give some idea of the amount of work done in 1864 and 1865. Since that time no account has been kept. Mr. Prout has given us a separate account for 1865, by which it is apparent that the result of 120 days' work is 879 acres done:—

1864 and 1865.

Class of Work.	Width of Implement.		Number of Acres.	Depth in Inches.		Days at Work.	Quantity per Day.			Working Expenses each Day.			Costs per Acre.		
	ft.	in.					A.	R.	P.	£.	s.	d.	£.	s.	d.
Subsoiling ..	1	10	289	14	15	82	3	2	3	1	14	0	0	9	8
Digging.. ..	2	6	193	10	11	38	5	0	12	1	14	0	0	6	8¼
Ploughing ..	3	4	712	8	9	100	7	0	19	1	14	0	0	4	9¼
Cultivating ..	6	0	581	8	10	47	12	1	17	1	14	0	0	2	9
			1775			267									

It is a noticeable fact that the proportion of work is less year by year as the farm advances toward a higher state of cultivation. Thus the tackle was standing idle from Nov. 16, 1865, till August, 1866. All was in corn; there was nothing to do. One operation now, where there are no weeds, and the land is mellow, suffices to produce a better seed-bed than double the labour would have produced in 1861. In preparation for roots, the wheat-stubbles are broken up with plough and subsoiler from 12 to 14 inches, the top furrow being turned down 7 inches, the tines running down 7 inches lower, and stirring, but not inverting the bottom. This operation, which takes from 80 to 85 lbs. steam pressure, and is done at the rate of 3½ acres per day, is completed in November. In April this land is crossed with a cultivator to a depth of 10 inches, a harrow being attached.

Cost of Work.

	Expenses per Day. £.	s.	d.
Manual and horse labour:—			
Engine-driver	0	5	0
Ploughman (wage and allowance)	0	3	2
Anchorman (wage and allowance)	0	3	2
Three porter-boys..	0	3	6
Man and horse for water-cart	0	4	0
Coals and oil	0	15	2
	1	14	0

Average daily wage, 2*s.*

Extra pay to ploughman and anchorman, 2*d.* an acre when 4-furrow

ploughing, making their wages up to 3*s.* 2*d.* per day; 1*d.* an acre when cultivating; 4*d.* an acre when subsoiling. Coal, "Staveley Hard," 20*s.* per ton, home; consumption, 12 cwts. per day.

The present horse power amounts to 8, this being just 2 horses to 100 acres. Three of these are to be dispensed with; but as the requirements of harvest, when they are felt, will necessitate 6 to make two sets, one must be bought just before it is wanted. The engine-driver is a competent mechanic from Messrs. Fowler's Works, who can shoe horses, for which object a smith's shop has been built.

It is scarcely necessary to state that the course here pursued is exceptional, and must soon come to an end. Manure will soon be needed. When this time comes, Mr. Prout is prepared to maintain a flock of sheep, to grow plenty of roots for them, and to feed the roots off upon the land, heavy as it is.

No. 11. Mr. Thurlow, Baynard's Park, Horsham, Sussex. This gentleman has recently purchased this beautifully wooded estate, consisting of 2000 acres. A small portion of it has been let in small farms of 150 and 200 acres; the remainder, 1400 acres, are in the owner's own hands. Of this portion 900 acres are arable. The land had been much mismanaged, and was in an exceedingly poor and foul state. For picturesque beauty, nothing could be better than spreading tree, sprawling tangled hedgerow, and deeply-rutted lanes; but for developing the wealth of the nation, this neighbourhood is sadly in arrear. A little light has been let into it lately by the construction of a railway which cuts through, and has a station on the estate, and looks astonishingly at variance with the water-logged soil, the rushes, and other evidences of England a hundred years ago. The sunlight is dealt out to the land through masses of wood. It is intended that the fields, which were of 3, 4, and 5 acres, should average 30 acres.

In prosecuting this work, about 600 acres have been reclaimed and rendered productive. The larger portion of the farm is heavy land; and though a portion of it is on the green sandstone formation, 450 acres are so stiff as to require the work of four horses to turn half an acre a day 6 inches deep. Part only of the requisite drainage is done, varying in depth from 4 to 7 feet deep, and from 1 to 2 rods apart. The benefit of deeply breaking up drained land cannot be disputed. The 4-course system of husbandry is followed; dead fallows are abandoned. Steam has substituted for dead fallow, barley, seeds, wheat; roots, barley or oats; seeds, beans, or peas; and wheat. Drainage and deep culture have rendered much of the land capable of carrying sheep. A flock of Southdown ewes, selected from Rigdens and other good breeders, is being formed. Nothing but the boldest of measures will effect the cure here needed. Half-measures and

timid counsels would, under such circumstances, be fatal to success; while a large expenditure, if directed with vigilance and judgment, must give large results. The working horses charged to the farm number 16, or 2 to 112 acres. When the same amount of land was divided amongst several tenants, they kept 2 to 56. The supply of water is good—generally from brooks, but partly from wells expressly dug to yield it.

The *Apparatus* was bought of Messrs. Howard, 1857.

	£.
The Engine, 8-horse power, single cylinder, made by Clayton and Shuttleworth, portable, used in grinding, sawing, thrashing, brick-making. It has been driven 5 days a week since 1857, and is provided with a commodious engine-house. Price	250
1 cultivator, windlass, 1400 yards of rope, porters, &c.	250
	500
Additions and carriage	50
	550

Repairs, Renewals, Wear and Tear.—Although the engine has been used, since 1857, five days a week, the average repairs were stated not to have exceeded 4*l.* a year. The fire-box will probably last four years longer. The repairs are done by a man who comes annually from Clayton's, and his own smith. The engine-driver, formerly a labourer, is a careful fellow. He has been instructed by Clayton's men—the entire engine having been taken to pieces and reconstructed before him. One secret of the small expense may be that, the engine being provided with a lock-up safety-valve, the maximum steam-pressure allowed to the driver is 45 lbs. A new rope of 700 yards was supplied, in 1863, which will last two years longer. The heaviest repairs are in rope and rope-porters.

Driven only with 45 lbs. pressure, it may be considered that an 8-horse power engine is too weak for the work.

Work done, and Mode of doing it.—Removals occupy half a day with four horses and three men. A day's work, including removals, is 6 acres, from 5 to 6 inches deep. In 1865, from April 22 to Oct. 7, 28½ days, 237 acres were broken up, 63 acres of which were three and four times done = 8½ acres per day average.

Cost of Work.—The daily wage of ordinary labourer, 2*s.* 2*d.* The manual and horse labour amount to 1*l.* 0*s.* 10*d.*; the coal, oil, and grease to 7*s.* 7¼*d.*—in all, 1*l.* 8*s.* 5¼*d.* per day. The windlass-man, whose work is looked on as the most difficult, receives 6*d.* a day extra. The coal is "hard," price 19*s.* per ton home; consumption, 6 cwts. per day of 10 hours, under cover, and 6 cwts. in the field.

The tackle was not at work, but was visible, under cover, and in very good state.

SECTION B.—MEDIUM OR MIXED-LAND FARMS.

No. 12. September 6th we visited the farms of Messrs. Impey and Bott, of Broomfield, near Chelmsford, tenant farmers, who have worked steam in partnership. Mr. Impey occupies a farm of 500 acres, on which 2 horses are sufficient to turn a furrow 6 inches deep. He is engaged with Mr. Marriage of Croydon in the wholesale milk trade in London, and keeps from 50 to 100 milch-cows; has but 50 acres of grass land, and is therefore obliged to depend very much upon green crops. Most of the soil rests upon clay: there is a portion upon gravel. All the clay has been drained either by hand or by Eddington's steam mole-plough, the latter work being 10 feet apart, 30 inches deep, and answering admirably. It is done by Messrs. Impey and Bott's own tackle, which is also let out in the district. The gravel land has been drained by hand when needful. The benefits of this work have been much increased by deep steam-tillage. The horses are reduced about one-third in number; but more is done. The carting of milk and grains occupies several. Mr. Impey, who has employed steam because he wanted more return from his land, says that he has not been disappointed. Not only does the additional power afford facility for getting more crops off the land—for this in a great measure is due to its speed—but by the deeper movement of the soil resources are brought into play which ensure heavier crops. The breadth of the root-crop has undergone no change, but greater weight is attained. A green crop is almost uniformly secured before turnips. Mr. Impey is of opinion that steam is of as much value to him on his light as on his heavy land.

The farm lies very well for steam. The fields have been enlarged, but no roads have been made. Water of good quality is supplied from ponds within easy reach, and the engine is generally fixed by the side, and feeds itself. Thrift, neatness, superior management, excellent root-crops, strong stubbles were apparent everywhere. No fancies are indulged; farming is undertaken for profit.

The *Apparatus* first obtained was Eddington's. It consisted of 2 engines mounted on windlass frames, a 4-furrow plough and connecting ropes. In this venture, which was found to be "too cumbersome," Mr. Bott took part. It was abandoned for 2 sets of Howard's tackle, the engines being retained, together with Fowler's 4-furrow, which are still worked between them. These 2 sets of tackle were bought July, 1861.

1 set of tackle cost	£ 200
1 engine 10-horse power, double cylinder, manufactured by Clayton and Shuttleworth	270
Half the plough	80
	£ 550

Repairs, Renewals, Wear and Tear.—No precise data as to repairs of engine, which is used for thrashing, and looks in very good cue. Mr. Impey's experience leads him to charge the work done with 1*s.* 6*d.* per acre on account of the rope, 2*s.* per acre on account of the implements, engine, &c., and 7*d.* per acre on account of wearing parts. The boiler is cleared of deposit once a month, and the tubes are drawn every second year.

Work done with the *Cultivator* in a day of 10 hours, exclusive of removals, which occupy 4 hours and require 8 horses, nearly 6 acres. With the 4-furrow plough from 8 to 10 inches, 6 acres. Since the commencement about 2000 acres have been worked. Very little work is done for hire. There is little or no time for it. The engine power is found to be quite sufficient. Much use is made of Fowler's plough. It is frequently used without breasts, and thus fitted, a "single operation with it is equal to two with the simple cultivator." The possession of the plough, too, is found to be of great advantage when cultivation cannot be done. Two anchors coupled are found competent to bear the strain.

Cost of Working.

	£.	s.	d.
Manual and Horse-work:—			
Engine-man	0	3	6
Ploughman	0	2	6
Windlass-man	0	2	6
2 boys	0	2	6
Horse for water-cart occasionally	0	1	0
2 anchor-men	0	4	0
	0	16	0
Coals	0	13	0
Oil	0	1	0
Total cost per day	1	10	0

N.B.—1*d.* extra per acre to each man, and ½*d.* to each boy while working, by way of stimulus. *Coal*—"Seaborne," price 21*s.* 8*d.* per ton home, consumes 12 cwts. per day of 10 hours.

Mr. Bott occupies adjoining farms, which consist of 490 acres (30 pasture) of better land than Mr. Impey's, but he is less advantageously situated for steam, the fields being many of them small irregular enclosures, which straggle away into other properties in such a way that nothing save a give-and-take arrangement amongst the neighbouring landowners could set right. Nothing but the roundabout system would, in his opinion, do here. The removals are very frequent, and in comparing the cultivation of his small fields with Mr. Impey's, he finds that in the long run he does about 1 acre a day less. Whereas the cost of coal to Mr. Impey is 2 cwts. per acre, to Mr. Bott it is 2½ cwts. He nevertheless persevered, from his high estimate of the value of

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steam power. Since 1861 he, like his partner, has done 2000 acres. The Apparatus is in all respects like the former—the two engines, which are employed two-thirds of their time off the land, are managed by well-trained men. The staple is rather a deep loam, upon a brick earth. The farm is most of it drained by steam. The horses have been reduced from 18 to 14.

The special utility of steam power has been witnessed in the case of a neighbouring farm of 140 acres in very foul condition, which was entered Michaelmas, 1865, by Mr. Bott, and put right, or nearly so, in a single year, without calling in any additional power. We saw the greater part of it and a splendid root-crop looking very clean. First it was drained by steam, then 3 times cultivated with Howard's implement, twice with Fowler's plough, once with breasts off, once with them on. The conversion could not otherwise have been accomplished in the time or at the cost, which was exceedingly moderate. Mr. Bott is a thoroughly practical man; he not only farms for profit, but profitably; his farm is well managed, and his stock well bred. These two cases may certainly be considered to present the claims of steam in a very favourable light in the neighbourhood where they exist.

No. 13. September 7th, Mr. A. C. King, Desning Hall, Higham, Suffolk. A long ride from Bury St. Edmund's over an open rolling country, timbered scantily and chiefly with fir, brought us to Mr. King's, who occupies 840 acres of land which have been in the family upwards of 70 years under a Mr. Farmer. Of this area 700 acres are arable, of which one-third is of heavy land, requiring 3 horses to plough 3 roods a day 6 inches deep, and the other mixed soil, upon which steam power has not been used. The heavy land lies mainly on the slopes of two contiguous hills, has a clay subsoil, and never before was known to grow roots. We found it not only producing fine crops of mangolds and turnips, but allowing of their being fed off occasionally, which shows that drainage—rendered more effective by deep culture—and deep culture itself, have combined to improve the texture of the soil in a marked degree. The drainage is done 32 inches deep 1½ rods apart. The fields lie in those large breadths so suitable to steam. The land which was in ridge and furrow is now laid on the flat, and fed with sheep, a novelty in the district on land of this sort. 400 breeding sheep are kept on the farm, and also 20 to 25 cows; and the produce from all these is annually fattened on the farm for market; the sheep being sold at a year to fifteen months, and the bullocks between two and three years old. The supply of water is inconvenient; it has to be all carted from a pond and well at the homestead, for which one man and horse are sufficient. The

water leaves very little deposit. The horse power has been reduced from 24 to 22, or 2 to 64 acres, which is excessive. The covenants prescribe the 4-course system, but the tenant is satisfied that any reasonable wish which he may entertain would not be denied him.

The *Apparatus*, bought 1862, and manufactured by Messrs. Howard, consists of—

	£.
A 12-horse-power, double-cylinder, traction-engine, by Burrell	335
1 cultivator, 1600 yards of rope, a windlass and porters	250
Total cost	585

The windlass is worked with connecting rod and universal joint.

The Engine is furnished with a commodious house, where it stands to drive the mill to thrashing and chaff-cutting machines. The engine-driver is a well-trained farming man. The number of days it is working could not be stated, but it was not more than one-third of its time working on the land. The implements and rope well kept under cover.

Repairs, Renewals, Wear and Tear.—The *Engine* was in very good condition. It is properly stayed to sustain a steam pressure of 80 lbs., but burns an excess of coal. We thought this probably due to the steam space being small—without a dome. The repairs of the engine, estimated by Mr. King, over a period of 4 years, at about 40*l.*, or 10*l.* per annum, the prime cost having been 335*l.* For the outlay on the steam tackle of late no account has been separately kept. He roughly estimates that the expenses of rope, engine and apparatus, including 10 per cent. for maintenance and renewal, have been 3*s.* 6*d.* per acre for each time of cultivating. Of this total, one item, 2*s.* 8*d.* per acre, is due to the rope and apparatus, and 1*s.* for the engine.

Work done and Mode of working.—During a day of 10 hours, including removals, 5 acres are completed, namely, cultivated and cross-cultivated, the implement going over 10 acres in a day. As yet, less than 100 acres have been worked twice each year. Mr. King expressed himself perfectly contented with this quantity for the past, but he intends to do more in future. He stands much in need of a plough. The clover-leys cannot be spared till the 15th September, and horses, which are not wanted the rest of the year, must, it is argued, be kept to do this and harvest work while the steam tackle stands idle. There are each year 175 acres of fallows, on nearly all of which either roots or vetches are grown, and this is certainly due in great measure to the steam apparatus. The preparation for the root-crop is as follows:—In October the land for mangold and early turnips is

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cultivated and crossed, and a Coleman's scarifier is run through the land just before sowing; this is generally found sufficient.

Cost of Work.

	£.	s.	d.
Manual and Horse-labour:—			
Engine-men	0	3	0
Windlass-man	0	3	0
2 anchor-men	0	3	10
Steersman	0	2	2
2 boys	0	1	8
1 boy and horse	0	4	0
	0	17	8
Coal	0	15	7
Oil	0	2	6
Daily working expenses ..	1	15	9

N.B.—No extra payment to men. *Coal*—"Staveley Hards," 18*s*. 4*d*. per ton home, consumption 17 cwts. per day of 10 hours, 15*s*. 7*d*.

The farm lay in a very creditable state, but we were struck with the comparative uselessness of machinery capable of rendering such unmistakable assistance, upon a farm of this kind, where horses, owing to the steepness of the inclines and the tenacity of the soil, work to great disadvantage. The consumption of fuel, too, is a serious increase to the expense. The charge per acre is somewhat heavy. Adopting Mr. King's mode of calculating the expenses, &c., the daily working expenses 1*l*. 15*s*. 9*d*. + the wear and tear and depreciation (1*l*. 15*s*. 2*d*.), make in all 3*l*. 10*s*. 11*d*., which spread over 5 acres gives 14*s*. as the cost per acre completed. Mr. King considers that since the engine is employed only 20 days in a year for cultivation, and nearly 50 days on thrashing, &c. &c., only one-third of its cost should be charged to steam cultivation. The charge for interest would then be, on one-third of 335*l*.:—

	£.	s.	d.
Cost of engine	111	13	4
Cost of other tackle	250	0	0
	361	13	4

Interest on 361*l*. 13*s*. 4*d*. at 5 per cent., 18*l*. 1*s*. 9*d*., or, divided among 20 days, 18*s*. 1*d*. per day. The account would then stand thus:—

	£.	s.	d.
Daily working expenses	1	15	9
Wear and tear at 7*s*. per acre, twice cultivated..	1	15	0
Interest at 5 per cent.	0	18	1
	4	8	10

Or 17*s*. 9*d*. per acre, twice cultivated.

No. 14. Mr. Chambers, Colkirk, Fakenham, Norfolk, September 11th. Arriving in the midst of heavy rain we were unable to make any acquaintance with the farm. Our visit was prompted chiefly by an expectation of seeing a set of tackle, the parts of which had either been invented by Mr. Chambers or adapted from other systems. In 1860 he adopted the roundabout system of working. The *Engine*, single cylinder, 8-horse power, is of Messrs. Garrett's manufacture. The rope, 1400 yards, was bad, and has just been increased by 700 yards. The *Windlass* is home-made. Different from most windlasses, the speed can be checked without checking the engine. The *Plough* is made by himself, mainly in wood, on the model of Howard's old balance 3-furrow plough, and is said to work well. The *Cultivator* is a converted "Bentall," with a seat for steersman on the hales, and a turning bow like that described as used by Mr. Cooper. It has 5 legs armed with shares or points, with 2 cutting-wheels in front. A square harrow carrying 7 feet, with a seat for the rider, is also a feature. This implement by working at speed does its duty well, and gets over about 15 acres a day.

Of *Work done* Mr. Chambers has no statistics. His cultivator breaks up from 6 to 7 acres; his plough ploughs from 5 to 6 acres a day.

	£.	s.	d.
Labour and water-carting come to	0	14	0
Coals 5s. 4d., oil 8d.	0	6	0
Interest on capital, wear and tear	0	12	6
Removals	0	3	0
Total cost per day	1	15	6

			s.	d.				s.	d.
5	acres ploughed,	costs	4	0	per acre, or	with interest, &c.		7	1
6	"	"	3	4	"	"		5	11
7	"	"	2	10	"	"		5	1
8	"	"	2	6	"	"		4	5

The outlay has, of course, been small upon the apparatus, and the engine has not sufficient power.

The farm consists of 597 acres of arable land and 110 acres of pasture. Part of the arable has been recently broken up from grass, and so cropped as to require more than the average amount of horse labour. 20 horses are now kept; and as a reaper is kept at work, and the corn is carted to the homestead, Mr. Chambers considers that he requires that number in harvest with a hilly farm, and, perhaps, a wet season. Steam has brought no general increase to the turnip-crop, but much of the land had been previously subsoil-ploughed, and some acres even trench-ploughed by horses previously. The engine thrashes, grinds,

[redacted]

and cuts chaff for about 100 head of stock. The steam plough did special service last autumn by getting in 150 acres of wheat in good time.

The number of horses kept appeared to us excessive, but in fairness we state the reasons alleged for retaining them.

No. 15. Mr. Alfred S. Ruston, Chatteris, Cambridgeshire, Sept. 12. This holding consists of six farms of all sorts of soil, from a strong clay to a blowing dust, and what is termed a hot dust. In extent it comprises 940 acres, 800 being arable. For the most part the farm lies in "high land" and "low land." The low is fen-land. The steam-power is generally used on the high—that is to say, on about 160 acres, where the following system of cropping is observed: 1, barley; 2, beans; 3, wheat. The wheat-stubble here is broken up by steam in the autumn, worked again in the spring, after which barley is sown. The bean-land is broken up by steam and cleaned for wheat. The established rule is to steam three times in three years, and to plough with horses once. On some of the fen-lands steam is used every five years. The usual course of husbandry is as follows:—1, fallow; 2, oats; 3, wheat; 4, seeds; 5, wheat.

The object for which Mr. Ruston bought the tackle is fully accomplished. This object is, on his own high lands, to get a crop every year, a fallow being formerly given every fifth year, and he expects by his present mode of management to keep his land as clean as when fallowed once in five years. The results of the two first years defrayed the whole cost of the apparatus; and now the land is as clean as it would have been under the old horse-system. A great deal of use of the apparatus has been made on the fen-land when nothing could be done on the high lands. Deep cultivation is here an invaluable process by mixing the clay and gravelly subsoil with the staple. Mr. Ruston has derived much advantage from turning up the soil with a plough purposely made for the work to a depth of 15 or 16 inches. This is only safe when the couch-grass is abolished. We found the finishing-stroke being given to the harvest. The crops generally fine. Mr. Ruston spoke of largely-increased yields since steam had been employed—fully one quarter an acre of barley and wheat. He has felt the advantage of despatch —steam has thus saved his barley-crop more than once: its use has frequently given him the benefit of the difference between putting the seed in well and badly. His horse-power was 26; it is now 20—2 horses to 80 acres. Mr. Ruston testifies also to the increased efficiency of the drainage effected by the introduction of steam. This we found to be no fancy; for, notwithstanding the heavy and continuous rainfall, the fields felt firm and dry under foot. On some of his own land he takes com-

crops year by year successively, where formerly a system of bare fallow prevailed. No special preparation has been made for steam-cultivation save the enlargement of the fields, which were and still are small. The supply of water is convenient and plentiful: in quality it is hard, which is not usual with pond-water. One boy, sometimes with, sometimes without, a horse, suffices to convey it to the engine. The land in the neighbourhood is for the most part in the hands of men who have taken no steps to encourage the use of steam-power.

The *Apparatus* was bought November, 1862, of Messrs. Howard. It consists of an

	£.	s.	d.
Engine, 10-horse power, single cylinder, made by Ruston of Lincoln, which had been in use 3 or 4 years for general farm-work. It is not let out, but thrashes from 500 to 600 acres of corn a-year, besides grinding, and tillage work, value	150	0	0
1 set of implements, windlass and rope (1600 yards)	230	0	0
Deep plough	60	0	0
Side-harrow	3	10	0
Carriage and man to start the tackle	20	0	0
	463	10	0

Repairs, Renewals, Wear and Tear.—The breakages have mostly arisen from the carelessness of boys. These, with wear and tear, have been very slight—principally in porters, wheels, and snatch-blocks, of which no exact account could be rendered. One *rope* has done all, and is now getting weak.

Work done.—In spring, 7 acres a day of 10 hours; in autumn, 8, 9, and 10 acres. Deep-ploughing, 2½ to 3 acres.

	Acres deeply Ploughed.	Cultivated.
1862	84	..
1863	71	247
1864	14	219
1865	20	338
1866 to Sept. 12	..	115
	189	919

N.B.—Removals are paid for by the hour. They occupy from a half to a whole day; 10 horses concerned in the removal.

Cost of work.—*Manual labour*, 5 men and 4 boys: when working by the day the ordinary payment is received, with 1*s.* 9*d.* extra for engine-man, windlass-man, and ploughman; when by the piece, they have 2*s.* 6*d.* per acre—working till 7 or 8 o'clock in the autumn.

	£.	s.	d.
7 acres at 2*s.* 6*d.*	0	17	6
Coal—"Portland" and "Brindley Hards," 15*s.* per ton, home; ½ ton per day	0	7	6
Oil	0	1	0
Total per day	1	6	0

No. 16. Mr. F. Battcock, Hemingford, St. Ives, Hunts, Sept. 13th. We found everything about Mr. Battcock indicative of sound sense and good practical farming. As in some other cases, so with him, steam is no plaything. If it could not be used profitably, it would soon be abandoned. Two farms united —one, Capt. Douglas's; the other the property of the Rev. J. Linton—make an occupation of 970 acres. Of arable land there are 700 acres. The two farms extend 3 miles from end to end. One consists of 450 acres of heavy land, with blue clay subsoil, where 3 horses find ploughing 3 roods a day 6 inches deep to be stiff work; the other consists of 450 acres of pair-horse land on a subsoil of gravel and yellow clay. The heavy land is drained 3 or 4 feet deep, the drains being from 10 to 11 yards apart. The fields are of a good size—30, 40, 50 acres. There is still a great deal too much timber about, which the landlord objects to remove. A plentiful supply of water exists in the ponds, but in quality it is not good. Some difficulty is experienced on the heavy-land farm to procure water in dry seasons. Mr. Battcock has searched through 70 feet of blue clay and 50 feet of clay and limestone for water, but without success. The heavy-land farm was taken in 1854.

One of the greatest advantages attending the introduction of steam, which took place in 1858, was, that the drainage, which had been undertaken earlier, began at once to act much better. This may be considered the key to every after improvement, tending as it does to increase the fertilizing power of every pound's weight of manure. It was soon found that the ridges could be turned down, and the crops grown on the flat. In 1861 so much improvement was experienced in the weight of the grain-crops as to make it politic to abandon the four-course, and to adopt the five-course system, which allows two white straws in succession. The landlord gave permission for this deviation from established custom. The tenant finds that though the 5-course gives less straw, it gives more corn; in fact, to use his own expression, "Five crops pay better than four." The change entails less harvesting, and less trouble with the men, who always endeavour to shirk the heavy-laid crops of the 4-course system. The rotation is as follows: 450 acres are so divided into 5 plots of 90 acres each, that the land comprised in these plots lies together, and can be cultivated with the smallest amount of shiftings possible; they are in beans and seeds, wheat, barley, oats, and roots. The land was strikingly clean, and the hedges, stacks, and general details all bespoke good management. The stock carried by the farm is 100 beasts and 1000

sheep all the year round. About 300 down breeding ewes are bought in every year and sold off fat. The lambs are carried forward and sold fat in the hogget stage. The 4-course husbandry is adopted on the light land, two green-crops being taken on the fallow-shift: this is only possible with steam. The horse-power has been reduced from 30 to 21. The proportion is now, therefore, 2 horses to every 70 acres. The reduction might have been pursued until only 2 horses were left to every 92 acres had not Mr. Battcock desired to keep five or six good mares to bring a foal every year. These mares are turned out about May, and are brought up for harvest. Their help and the steam together so much eases the work falling to the other horses that "they require," Mr. Battcock said, "one-third less corn."

The *Apparatus* was bought of Mr. Smith in 1856. It consists of the

	£.
Engine, of 10-horse power, made by Messrs. Roby of Lincoln	260
2 cultivators, 5-tine and 3-tine, a windlass, driven by strap, since then a scarifier to take 6 feet, and 1400 yards of rope	180
And a drill, made by Butlin of Northampton	50
	490

The windlass and 2 cultivators are of Smith's original model, and were found in a good state. The scarifier, to take 6 feet, was of the same shape, having two rows of tines and front disc-wheels. The engine, with 12½-inch cylinder, and simple reversing-gear and steel fire-box, which he does not recommend, was in good repair.

Repairs, Renewals, Wear and Tear.—The repairs are heaviest on *cultivators*, which is mainly due to the wheels. The wear and tear of *rope* is very slight. Two new ropes have been purchased. The first rope was very bad; the next very good—it has lasted three seasons. The present rope is now two-thirds gone. The repairs of the engine over the whole period of ten years would be 100*l.* The present fire-box, a steel one, will last two years longer. The engine being employed in other farm-work, steam cultivation should only be debited with half the repairs incurred.

Work done, and Mode of doing it.—During a day of 10 hours, removals (which occupy 2 hours) included, cultivating 6½ acres; scarifying, from 16 to 20 acres; drilling (9 coulters 8 inches apart), 9 acres. In preparation for roots, the stubble is broken up with the 3-tine, and crossed with the 5-tine; men are set on to throw out live couch-grass where it may remain; the land is then manured and ploughed with horses, and sown.

Cost of Work.

	£.	s.	d.
Manual and Horse-labour:—			
Engine-man	0	3	6
Windlass-man	0	3	0
Ploughman	0	1	6
2 boys, 9*d*.	0	1	6
2 anchor-men	0	4	0
Horse and boy	0	4	0
	0	17	6
Coals	0	8	0
Oil	0	1	0
	1	6	6

N.B.—Daily wage in the neighbourhood, 1*s*. 10*d*. Experience has proved to Mr. Battcock that piecework by steam has cost double in repairs. *Coal*—"Langley hards," 15*s*. 9*d*. per ton home; consumption, 11 cwts. per 10 hours.

The straw of steam-drilled wheat is found to be much stronger than the other. The seed, being deposited upon a hard floor, flourishes better, grows with stouter straw, and less flag. Labourers at harvest generally evade such crops.

Steam has made little way in the fens. The anchor of the lighter sets of tackle will not hold, and for the heavier the land is too rotten. Mr. Battcock is of opinion that no man established in business with less than 500 acres should embark in steam. A young man beginning might do so with 300 acres of ploughed land. The cases are different where a man has all to buy, and where he has to dispose of the power that has served him to make way for that which is to serve him better. A man already possessed of horses and implements would have to sacrifice 100*l*. in quitting them for steam. Had this gentleman to start again, he most emphatically stated that he would do so with the apparatus he now has in preference to any other; and that he would never more attempt to farm without steam. Has long given up keeping separate accounts. Harvesting is done with carts.

No. 17. Mr. Thomas Hammond, Penshurst, Tunbridge, Kent. This gentleman's farm consists of 540 acres, about half pasture and half arable, a stiff clay, and likely to benefit from deep culture. He has only entered upon it within the last twelve months; but his case is remarkable, as he is one of a company, of twenty shareholders, which has been formed, one-half being farmers, to buy and work a set of Fowler's tackle.

The *Apparatus* was bought Sept. 1865. It consists of Fowler's two engines of 14-horse power, double cylinder, traction, 800 yards of rope, a 4-furrow plough, a 7-tine cultivator; cost 1573*l*. The engines are not fitted with the clip, but with winding-drums.

Repairs, Renewals, Wear and Tear: 6*d.* per acre for tines and shares; 6*d.* per acre for wear of rope. No other repairs at present.

Work done, and Mode of doing it.—During a day of 10 hours, with steam-pressure from 60 lbs. to 80 lbs. per square inch, including removals; ploughing 5 to 9 acres—in some cases 1 acre per hour, 10 inches deep; digging more. Cultivating 10 to 16 acres 12 inches deep. 500 acres were broken up from Christmas 1865 to 30th June last.

The time required to take up and set down and run a distance of a quarter of a mile is about one hour, no horses being needed. To prepare for roots, the system is to turn up the stubbles, in autumn, 10 inches deep, run the cultivator across in April, and then work with horses; steam can also be used with great advantage to break up the turnip ground for barley in spring.

Cost of Work.

	£.	s.	d.
Manual and Horse-labour:—			
2 engine-men	0	7	0
Ploughman	0	3	0
2 porter-boys	0	2	0
1 man and horse	0	5	0
	0	17	0
Coals	0	19	0
Oil and grease	0	2	0
	1	18	0

N.B.—The day is 10½ hours. No extra pay is given except for overtime. Coals—"Hard," 19*s.* per ton home; consumption, ½ a ton to each engine.

This set of tackle is sent out on hire, and does—

			s.		s.	
Ploughing	10 inches deep at		15	to	20	per acre.
Cultivating	12	"	10	to	14	"

The fields in the neighbourhood vary from 9 to 30 acres. Just one-third more work is done in a given time where the fields are of 30 acres than where they are of 9 acres. It is discovered that a furrow from 350 to 400 yards can be ploughed with most economy. A double engine set of tackle might, in Mr. Hammond's opinion, work with advantage upon a 600 or an 800-acre farm. There are two thrashing-machines and portable mills belonging to the company. Such an appliance could be well employed where the holding was in two farms, seeing that the two engines could be located at the several homesteads. The double set consumes, in the same space of time, about 35 per cent. more coal than the single set. Care has been taken to select good engine-drivers: one is a mechanic from Fowler's

works; one is an instructed farm-labourer. An engine-shed is being prepared. No dressing is used with the rope.

This company has already experienced the difficulties that will beset most similar undertakings. The members all require the tackle at the same time. The preference is of course given to shareholders; these are comparatively few—or at least the farmers amongst them are few—and the double set is rapid in its work.

Amongst the landowners in the district there is a disposition to favour steam: they are ready to allow their tenantry to make the necessary improvements. It is, however, the cost of the tackle which restricts its application.

This visit was made after such a tremendous rain that no attempt was made to see either the work done or the apparatus.

No. 18. Mr. George Morgan, Ninfield, near Hastings, Sussex, September 24th.—This gentleman occupies his own land—260 acres—out of which 30 grow timber, and 20 are in grass, leaving 210 acres of arable, a loamy clay lying on a sand-rock subsoil very pervious to water. Only 70 acres have required drainage. In some portion the drains are laid 4 feet deep, 2 poles apart; the rest is drained irregularly to catch springs. There is a good supply of water strongly impregnated with iron. The farm did lie in fields of 6 or 7 acres. The average size is now 20 acres. Much has been done on this farm since its purchase in 1861 to fit it for steam cultivation. The surface, however, is very hilly, and it is so intermixed with other holdings that straight fences are out of the question, unless adjoining landlords will agree to "give and take." Through the farm runs a public road.

Mr. Morgan estimates that the apparatus has supplied the place of 5 horses during 3 years. At one and the same time a house and farm buildings had to be erected, and a foul farm to be made clean, which it certainly now is. It would have been "impossible" for him to have hauled the building materials, and done the work of the farm with less than 12 horses. When the haulage was being done, the farm work must have suffered neglect. He has had not more than 7 horses.

The course of cropping pursued is as follows: 1, roots; 2, barley or oats; 3, seeds; 4, wheat. The old system in Sussex was wheat, oats, and fallow and peas, where no beet. The crops are continually increasing — a fact which is due to a liberal supply of manure and good drainage, as well as to deep culture.

The *Apparatus* was bought in the spring of 1861 of Messrs. Howard. It consists of a 10-horse power double-cylinder portable *Engine*, bearing Clayton and Shuttleworth's name; a

5-tine *Cultivator*, windlass, plough, and 1600 yards of steel-rope; 525*l.*

The engine drives the windlass with a strap. It is used also for thrashing sometimes, when Bury and Pollard's mill-sails can catch no wind for grinding and chaff-cutting.

Repairs, Renewals, Wear and Tear.—The *engine* and tackle have cost about 20*l.* at the yearly overhauling. Mr. Morgan calculates that if worked 100 days in the year, 20 per cent. on the prime cost would keep all in repair, and supply the means for a new set of tackle in 8 years. His would amount to a charge (taking half the price of the engine) of 75*l.* per annum. 2 *ropes* of 500 yards each (50*l.*) supplied since 1861. The rope and rope-porters have been the greatest expense. The inclines are so frequent and sharp that the porters are cut through in astonishingly short time.

Work done and Mode of doing it.—During a day of 9 hours 4 or 5 acres may be cultivated per day, 6, 7, 8, and 9 inches deep, which requires as great a strain as an engine will exert with 60 lbs. of steam. The work done in various fields from the 9th October, 1865, to the present date, is as follows:—a 16-acre field worked in October the 9th, 10th, 11th, 12th, 13th, 14th, and November 6th. The tillage executed once, twice, and some parts three times, amounted to 40 acres; which, divided by 7 days, gives 5¾ acres per day. The next was a field of 12 acres. The working days were the 7th, 8th, 9th, and 16th of November, 4 days to 12 acres (only once cultivated), or 3 acres per day. The apparatus worked during March, 1866, 10 days. 8 days in April were consumed in cultivating and harrowing 30 acres, which gives 7½ acres a day. These facts are given, not to show the great use which was made of the apparatus, for less could scarcely have been done, but to show what really was done.

Cost of Work.

	£.	*s.*	*d.*
Manual and Horse-labour:—			
Engine-driver	0	3	0
Ploughman	0	2	3
2 anchor-men	0	4	6
Windlass-men	0	2	3
2 boys	0	1	4
1 boy and horse	0	4	0
	0	17	4
Coal and coke	0	10	6
Oil	0	1	0
	1	8	10

N.B.—Men are paid for overtime 3*d.* an hour. Fuel—Coke and coal: coke, 17*s.* a ton; coal, 25*s.*; consumption, 8 cwts. per day of each.

This whole district appeared to us to be sadly in arrear, little or no spirit being observable in landowners or their tenantry. Rent ranges from 10*s*. to 25*s*. an acre, and yet we found that where the land was well farmed an average yield of wheat was 4 qrs. per acre. We were told of tenants being under covenant to reap their white-straw crops with a sickle. The rate of wages in this part of Sussex was during last year increased from 12*s*. to 13*s*. 6*d*. per week—the hours being only from 7 till 5, with an hour for dinner. Their labour is poor in quality, and dear in price.

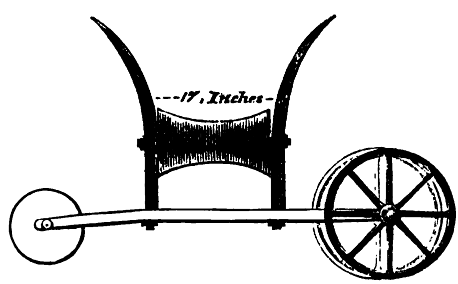
No. 19. Mr. G. Palmer, Bengeo, Ware, Hertford, September 20th. We met with a hearty reception from Mr. Palmer, who has thrown into steam cultivation—as he appears to do into all he undertakes—an energy and enthusiasm which helps him to overcome obstacles that would daunt others. He occupies about 1000 acres, lying apart from his house in two farms; one of 450 acres at Watton, 3 miles away, one at Bengeo of 550 acres. Of the total quantity 800 acres are arable. The heavy land is confined to the Watton farm, where 3 horses turn a furrow 6 inches deep at the rate of 3 roods daily. The soil there is a stiff clay. At Bengeo the soil is lighter—a gravel on wet clay. Mr. Palmer has rented the farms 28 years from Messrs. Parker and Smith. The Watton land is drained 4 feet deep 2 poles apart (the interval should be less). Water of good quality is plentifully supplied from ponds. The fields vary from 25 to 60 acres. The landlord has permitted his tenant to expend 200*l*. in stocking up hedgerows. The surface of the Bengeo farm is very undulating, and somewhat difficult to cultivate. The 4-course system of cropping is generally adopted in the district. This did not satisfy Mr. Palmer, who substituted for it the following:—barley, clover for sheep-feed, wheat, oats, turnips. This is followed on both farms.

The *Apparatus* was bought in February, 1863. It consists of—

	£.
An *Engine*, 10-horse power, double cylinder, portable, made by Messrs. Garrett	290
A *Cultivator*, 1600 yards of rope, windlass, &c. (Howard's)	210
	500
Extra porters, home-made, 25*l*., 1 set of harrows, 25*l*. ..	50
	550

Repairs, Renewals, Wear and Tear.—The *Engine* has not cost 5*l*. since it was purchased. The engineer, a thorough mechanic from Garrett's, looks ahead and detects weak places, bad joints, &c., before they lead to general mischief. Without such a man

Mr. Palmer feels confident that his repairs would have been very heavy. He has a smith's shop of his own, where repairs are soon effected, and he would recommend no farmer to buy a set of tackle without having such a forge. Since 1865 there have been 2 engines of 10-horse power. He can work with either, but one is usually employed abroad for thrashing on adjoining farms. A new *rope* of 1600 yards has been purchased since 1863, which is now about half worn. The original wheels of the *cultivator* were soon used up: larger ones of wood made at home were supplied, which have worn much better. The implement has been strengthened in all its parts. There were no means of getting at the cost of repairs with any exactness. The apparatus being at work we inspected it. The engine we found in excellent condition. It was driven at great speed, and the implement kept the porter-boys on the full trot in the discharge of their duties—the pace was fully 5 miles an hour. The rope was carefully supported. We found a rope-porter with wooden roller in great esteem—also home-made. It is made at a trifling



expense. The wooden rollers are replaced as soon as worn by the wheelwright, and the wear of the rope is perceptibly reduced by their use. The iron rollers last no time under the pressure of the rope over the summits of the sharp inclines which here abound. We observed that the snatch-blocks were blocked up at either end of the implement's course to keep them more level with the implement. Mr. Palmer and his son had evidently given great attention to the working of the apparatus, and had mastered its details so thoroughly as to enable them to supply several deficiencies.

Work done and Mode of doing it.—During a day of 10 hours with *cultivator*, the first and second time over, inclusive of removals, 8 acres a day 6 or 7 inches deep; with *harrows* (harrows 10 feet by 6) once and twice over, 16 acres a day. In preparation for roots the stubble is broken up in autumn with one or two harrowings, which would be better omitted if the land is clean, followed by a cross stirring in the spring.

Cost of Work.

	£.	s.	d.
Manual and Horse-labour :—			
Engineer	0	3	6
Windlass-man	0	2	0
2 anchor-men	0	4	6
Ploughman	0	2	3
2 porter-boys	0	3	0
Boy, horse, &c.	0	6	6
	1	1	9
Coal (15 cwts.)	0	12	0
Oil and grease	0	1	6
Total daily expenses	1	15	3

N.B.—Coal, 16*s.* per ton home; consumption per 10 hours, 15 cwts. = 12*s.*

Examples of work done abroad :—A 24-acre field cultivated once, harrowed twice = 72 acres, 5 days at 1*l.* 16*s.* per day = 9*l.* = 7*s.* 0½*d.* per acre. A 22-acre field cultivated twice, ½ three times = 55 acres in 6 days at 1*l.* 16*s.* per day = 10*l.* 16*s.*

The number of horses kept on the Watton Farm before steam were	16, there are now	12
The number of horses kept on the Bengeo Farm before steam were	18, there are now	12
	34	24

The reduction, therefore, amounts to 10, and leaves 2 horses to 66 acres of land—a very large disposable horse-power—which with the 10-horse power engine should be more than sufficient. For want of a plough, surplus horses are, clearly, kept to do what otherwise might be done by steam. The distance of this farm from the house causes, of course, more outlay in this direction. Mr. Palmer is, however, perfectly satisfied with the result, and states that the corn-bill is now 200*l.* a year less than it used to be. He considers that if he had the Bengeo farm with 18 horses and the present engine it would be good policy for him to lay out 500*l.* in engine and tackle only to work 4 or 6 weeks after harvest, and lie idle all the rest of the year. 5*l.* per cent. on the 500*l.* (= 25*l.*) would suffice to keep it in working order. Speaking of his own district, he considers the want of means on the part of the farmers a sufficient barrier to the application of steam. For the most part they have more land than their capital will cover. The landlords, too, are obstructive; they are far too fond of game to allow the wide, sprawling, irregular hedgerows to be grubbed up. We listened to a strange tale about the combination of labourers to break up the machinery. But the spirit of the thwarted master rose with the difficulties that opposed him. Men were procured from a distance, to whom good wages were paid; the work then went on in first-rate style; for, seeing that he could do without them, his own people begged to be employed, and have since worked well.

No. 20. Mr. J. L. King, Thorpe Hall, Scole, Norfolk, September 10th. Mr. King, being unavoidably absent, kindly provided a substitute, who did the honours of his house, conducted us over the cleanly, well-managed farm, and gave us all the information in his possession. This gentleman, Mr. Bate of Shimpling Place, Diss, having taken great pains to collect reliable data on the question of steam cultivation to lay before a neighbouring Farmers' Club, had watched the process conducted on Mr. King's farm with great closeness, and for one year had obtained a daily return of the work done, for the purpose of comparing the result with that obtained by Mr. Cooper and others.

The farm consists of 660 acres—grass, 54; wood, 40; arable, 560, two-thirds heavy, one-third light and mixed. Three horses plough 3 roods a day, 6 inches deep, on the heavy land. The subsoil of the stiff land, which is drained 44 inches deep and 7 yards apart, is an adhesive brick-earth, mixed with stones; that of the light land is a gravel. The farm has been 16 years in Mr. King's occupation and is farmed on the 4-course system. He hires the land of Mr. Holland of Bedham, near Saxmundham, who has granted permission to straighten fences, enlarge fields, &c., and something in this direction has been done. The fences are not *irregular*. The largest field was one of 19 acres, the smallest one of 6 acres. We were informed that great benefit had been derived through the drainage having been rendered more effective after the soil had been deeply broken up by steam: also from the larger area of root-crop obtainable, the heavier crops harvested, and the ability acquired by the land to carry sheep without injury. As to sheep, the advantage is felt on the heavy land being so soon ready to receive them after rain. It may also be mentioned that, while they are putting in barley in that district during March and part of April on the heavy land, it is of the utmost importance that the fallows should be forwarded at the same time; and this, during his use of steam, Mr. King has been able to accomplish. The land which was in ridge and furrow now lies on the flat; the stubbles over which we walked indicated heavy crops, and crops free from weeds. The turnips and mangolds were very fine; and have generally been far more certain since steam has been employed, simply because the season has been caught and properly used. The failure of part or the whole of a root-crop is frequently due to the absence of the supplemental power of which Mr. King has availed himself. The number of horses was 20; it is now 15. This gives 2 horses to 75 acres arable—too many, as we ventured to remark. It was explained, however, that a new farm of 106 acres was in expectation, which would be worked with the same power as that now in operation. The teams, of course, have less work, and are main-

tained in as good condition at less cost: indeed a greater reduction has been thus effected than in the number of horses kept; instead of 7 stones of meal per horse, he now gives 5. On inspecting the account of labour done, it will be seen that the possession of so many horses has proved a strong temptation to let the tackle rest. That only 217 acres were once cultivated between the autumn of 1865 and the spring of 1866, inclusive, is proof sufficient that steam had not often been got up. It was contended that the 300 acres of grain usually cut and stacked could not be harvested with less than 14 horses, which, in order that they may be in readiness, must have work found for them the rest of the year. We maintained that, provided the corn was stacked in the field and 1-horse carts used, 11 horses would suffice—9 for as many carts, 1 for a horse-rake, and 1 for a water-cart. The habit is to use 7 carts and 2 waggons. It is difficult to discover the avowed impossibility of supplying any additional need when the need was felt, and then of reducing the power to its previous dimensions. When horses are kept, the prevailing feeling is that they must be employed; it would not do to see the steam-engine puffing away, and the horses looking over the strawyard-gate at it, so the engine rests. But this course is frequently bad policy, for it would often prove better to spare the horses and work the engine. The addition of a plough to turn over the clover-leys would enable this gentleman to reduce his horse-power still further.

Mr. Bate is of opinion that none but the roundabout tackle and stationary engine is applicable to that part of the country. He spoke of many obstacles to the progress of steam-tillage, particularly on the heavy soils, the fields being very small, the boundaries irregular, and cumbered with trees, which struggle even into the fields, which vary in size from 3 to 12 acres. Yet they are bigger than they were thirty years ago. If steam cultivation were more generally introduced, he had little doubt that the landlords in this district would allow the removal of many of the trees, and of the unnecessary hedgerows. There seems now to be a disposition to make these fields larger, and to introduce steam.

No special provision has been made for water, which is found in ponds and is of good quality.

The *Apparatus* was bought of Messrs. Howard and Burrell in 1862. It consists of—

	£.	s.	d.
An Engine of 12-horse power, double cylinder, traction, made by Burrell, which is used in thrashing, abroad and at home, grinding and chaff-cutting	450	0	0
A windlass, cultivator, snatch-blocks, porters, and 1600 yards of rope, made by Howard	236	7	10
A Cultivator on Mr. Cooper's model, made by Burrell ..	35	0	0
	721	7	10

Repairs, Renewals, Wear and Tear.—The repairs of the *engine* have been very slight; there is a good engine-shed, and a careful engineer, who keeps the engine in a very creditable state, and escapes breakages and wear which those ever incur who see what is amiss too late to remedy it without great cost. He is provided with a portable forge and vice. The mud-holes are cleaned weekly. The *rope* broke four times with kinks. It has been working four years, and will last the fifth. The frame of Howard's *cultivator* has been pulled out often by tree-roots. On Cooper's there has been no outlay. The windlass was in a good state; all has been carefully used. The apparatus was not at work. Mr. Bate bestowed great praise on Cooper's cultivator.

At the close of 1863 Mr. King made a careful computation of expenses, which was published. Before quoting from the statistics which were placed in our hands, we deemed it prudent to write, requesting to know whether his present coincided with his past experience. He replied, "When I first commenced steam cultivation, I paid great attention to every part of the apparatus, and found that I must charge for engine, 10 per cent.; rope, 20 per cent.; windlass, snatch-blocks, &c., 5 per cent.; and after four years' experience I do not consider that I have made an excessive charge for wear and tear."

Mr. King's capital account shows how both wear and tear and interest are computed to fall upon the several parts of the apparatus:—

			Wear and Tear per Cent.	Charge for Wear and Tear calculated per Annum.	Interest per Cent.	Charge for Interest calculated per Annum.
	£. s. d.	£. s. d.		£. s. d.		£. s. d.
Engine	..	450 0 0	5*	22 10 0*	2½*	11 5 0*
Windlass ..	65 0 0					
Double snatch-blocks	12 0 0					
Cultivator ..	21 0 0	128 5 0	7½	9 12 4	5	6 8 3
Porters	13 15 0					
11 ditto	16 10 0					
6 snatch-blocks	18 0 0					
8 anchors ..	10 0 0	42 2 10	7	3 10 9	5	2 8 1½
Sundries	14 2 10					
Rope	..	60 0 0	20	12 0 0	5	3 0 0
		680 7 10		47 13 1		23 1 4½

* One-half the wear and tear and interest of engine, the other half being charged to other work.

Mr. Kersey Cooper has entered into a similar calculation.

The report of his experience will follow the present; but, for purposes of direct comparison, we prefer here to insert a similar extract from his capital account:—

	£. s. d.	£. s. d.	Wear and Tear per Cent.	Charge for Wear and Tear calculated per Annum. £. s. d.	Interest per Cent.	Interest calculated per Annum. £. s. d.
Engine	..	420 0 0	5	21 0 0	2½	10 10 0
Snatch-blocks ..	17 10 0					
Windlass ..	40 0 0					
10 porters ..	7 10 0					
14 rollers ..	3 10 0					
14 ditto ..	2 16 0					
5 anchors ..	10 0 0	120 13 0	7½	9 1 3	5	6 0 6
4 ditto ..	7 10 0					
Cultivator ..	20 0 0					
Porters	10 0 0					
Sundries	1 17 0					
Rope	..	80 0 0	20	16 0 0	5	4 0 0
		620 13 0		46 1 3		20 10 6

The Work done and the Method.—Working with an average of 60 lbs. steam-pressure, 10 hours a day, including removals and stoppages:—

From the autumn of 1862 to the spring of 1863, 394 acres were once cultivated from 7 to 7½ inches deep, in 55 days, which is equal to 7 acres a day.

From the autumn of 1863 to the spring of 1864, 315 acres were once cultivated from 7 to 7½ inches deep, in 46 days, which is equal to 6¾ acres a day.

From the autumn of 1864 to the spring of 1865, 217 acres were once cultivated, but in what number of days was not ascertained.

A harrow was used behind the cultivator during a wet part of the season, and worked well at a time when it would have been too wet for horses. In preparing for mangolds, it is Mr. King's practice to cultivate twice in autumn, to manure in winter, to plough on the flat with horses. Sometimes he cultivates once with steam 7½ inches deep, ploughs with horses, and manures and ploughs in spring. On this subject Mr. King expresses a very strong opinion. He says that one cultivation or breaking up on his heavy land answers better than two; it leaves the land more open for winter influences. This one is followed by a stirring in March, and again in the end of May or the beginning of June. The total cost in this case, allowing for harrowing, was 1*l.* 4*s.* an acre in 1863. It is a noticeable fact that the same year a practical valuer gave from his books three examples of

charges allowed by him for fallowing, viz.:—No. 1, 2*l.* 11*s.* 10*d.*; No. 2, 2*l.* 12*s.*; No. 3, 2*l.* 13*s.* In a letter dated November 24, Mr. King states that the cost for similar work, during the past year, has been 1*l.* 15*s.* In 1864 he made a fallow of 86 acres for 1*l.* 12*s.* 9*d.*, steam and horse-power included; and of 24 acres of light land for 2*l.* 3*s.* 9*d.*, by horse-power alone. Now that he has abandoned one of the two autumn stirrings, the first amount, which includes both, would be reduced to 1*l.* 4*s.* 1*d.* Mr. Kersey Cooper's fallows on 45 acres of light land, in 1864, are stated to have been prepared at a cost of 19*s.* 4*d.* an acre (10*s.* being deducted on account of expenses connected purely with the rye-crop which preceded the roots):—

Cost of Work.

	£.	s.	d.
Manual and Horse-labour:—			
Engine-driver	0	3	6
Windlass-man	0	3	0
Ploughman	0	1	8
2 anchormen	0	3	4
3 boys	0	2	0
1 boy and horse	0	3	6
	0	17	0
Coal	0	12	6
Oil..	0	1	0
	1	10	6

N.B.—Coal, 17*s.* per ton, home; consumption, 15 cwts. per day of 11 hours.

The quantity of work done between the autumn of 1863 and the spring of 1864 amounted to 315 acres. The aggregate expenses and the expense per acre are as follows:—

	Aggregate. £.	s.	d.		Per Acre. s.	d.
Manual-labour, coals and oil	62	7	9	..	3	11¾
Interest of capital, wear and tear	70	14	5½	..	4	5¾
Horse-labour for carting water, deducting 2*l.* 6*s.* 10½*d.* for harrowing 62 acres ..	5	1	2	..	0	3
	138	3	4½		8	8½

For the sake of comparison, it may be as well here to insert the aggregate and the acreage expenses incurred by Mr. Kersey Cooper the same year. The acres worked amount to 731; depth from 6½ to 7½ inches; time, 65 days, or 11 acres per day:—

	Aggregate. £.	s.	d.		Per Acre. s.	d.
Manual-labour, coals and oil	106	2	1	..	2	9¼
Interest and wear and tear	66	11	9	..	1	10
Horse for carting water	6	10	0	..	0	2
	179	3	10		4	9¼

The difference here is due to the heavy nature of the land and the smaller area of the fields in Mr. King's case. Mr. Cooper's fences are straight, his fields are large, his soil comparatively light. By placing his 731 against Mr. King's 315, the latter is thrown up in the scale; but, beyond this, Mr. Cooper gets over more ground.

Mr. King's tackle is under no circumstances let out, lest it should either be badly used or the men dawdle when removed from the master's eye. Mr. Bate considers that it would be practicable in the neighbourhood of Diss for farmers of 300 or 400 acres to lay out 300*l.* in tackle, and to hire an engine when required. In some cases, such as isolated districts, the engine would find full employment, thrashing, &c.; then, of course, the whole apparatus should be obtained.

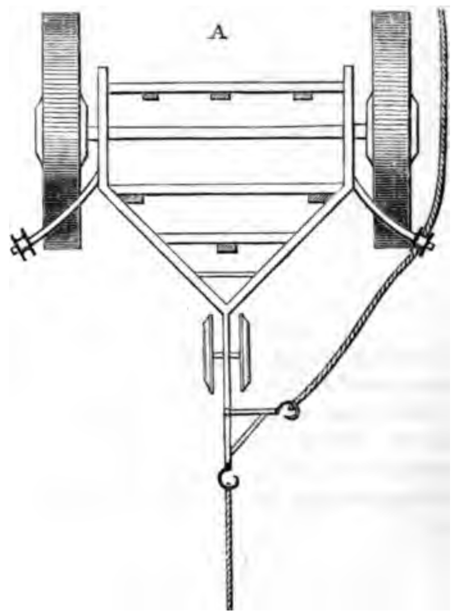
No. 21. The same day that we inspected Mr. Greene's farm, we paid a visit to that which Mr. Kersey Cooper holds of the Duke of Grafton, whose agent he is. The Bowbeck Farm is in the parish of Bardwell, 9 miles from Bury St. Edmunds. The land is moderately stiff, the subsoil a brick earth, lying at various depths. Upon two-thirds of the farm a stubble furrow 6 inches deep is turned with some difficulty by 2 horses; on the heavier part of the land 2 horses will not plough more than 3 roods a day at such depth. The whole is quite level and under-drained, 3 feet deep, and laid into good-sized fields, only 3 less than 20 acres, but most of them over 40 acres, with straight hedges, trimmed low, and destitute of timber. This farm is particularly well situated for water supply, as in almost every field there is a water pit from which clay has been carted out, and against which the engine usually is set—a small boy is sufficient to put it into a tub. The farm has been in Mr. Cooper's possession for 20 years; on a strip of his own land adjoining he has exercised good judgment in building a block of cottages which are models of good taste and convenience. They speak to the discovery on his part that a good house has something to do with a good workman. If it does not help to make him, it serves to attract him. In the centre of the block is a large room, which is lighted and warmed, supplied with papers, books, games, and coffee, hung with diagrams of machinery, &c., and opened to the farm labourers and others during the evening hours for a very small charge. With men so cared for and improved, he has brought his farm to a state of uncommon perfection. The Committee did not in the whole of their tour see one more worthy of remark, and they can but express their regret that the rain falling in torrents prevented such an inspection of it as they could have wished, to enable them to make an adequate report. Their opinion is, however, confirmed and

justified by the fact that at the last distribution of awards the Eye Association not only gave the prize to Mr. Cooper for the best cultivated farm, but also gave him the cup for the best flax-crop.

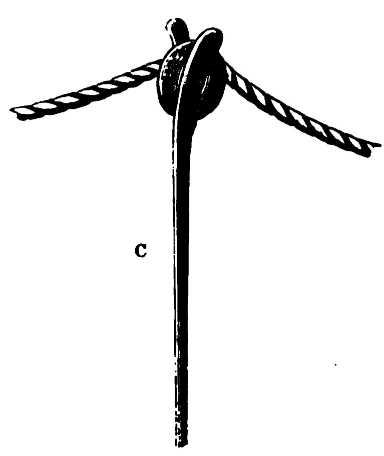
The farm consists of 800 acres arable, 300 pasture, inclusive of sheepwalk. Mr. Cooper is a most decided advocate for steam cultivation. M. Bate, a thoroughly practical observer, not yet in a position to employ steam (and referred to in No. 20), expressed himself before the Eye Farmers' Club in the following language, two years since:—"Mr. Cooper informs me, after an experience of four years, that he would on no account farm without steam. He now grows on most of his fallow land an intermediate crop, such as tares, rye, Italian rye-grass, cabbages, coleseed, so as to enable him to keep an immense quantity of stock. He has reduced his horses, and is still able to do a great deal of claying without extra strength, which used to be done by extraneous hands at 7*d.* and 8*d.* a load. I have known his land for many years, and can bear testimony to its improvement. A large portion is of a description most difficult to keep free from grass—more particularly with the intermediate green croppings, and this used to be a source of annoyance and hindrance; but steam has beaten, and, as far as I can see, eradicated it." After a further experience of two years, Mr. Cooper more than confirmed this statement. It has enabled him, he said, to increase his head of stock per acre, and to grow more corn. Much of this would doubtless have been done without steam, and is due to liberal manuring; but, as we have before observed, the virtue of manure, like the virtue of drainage, is educed by deep culture. The land now usually carries 700 ewes, 1000 hoggets, besides lambs in the spring, 130 neat-stock, and never less than 100 pigs, of which several hundred are frequently grazed in the yards when the cattle are fatted off. This increase of stock is effected by the increased facilities for the growth of rye as spring green food; steam has rendered it possible to get 150 acres in place of 35 acres. In place of 30 horses we found 18, or 2 to 90 acres arable. These animals looked in good condition, and are not worked so hard, we were assured, as they were formerly. Be it observed that the horse-power employed before steam was equal to 2 horses to 60 acres, which is not greater than some men seem to think it necessary to have at command in addition to a steam-engine and tackle! The farm is cultivated on the 4-course system, allowing for 2 crops in the fallow shift. Steam has not made much way on the Duke of Grafton's estate as yet, though we cannot imagine how, within the sphere of such an example, men who are possessed of sufficient capital can resist the temptation offered to them.

The *Apparatus.*—Mr. Cooper began in 1860 with an old set of Smith's tackle, exchanged for a cart colt. He took it to pieces, acquired a good knowledge of its details, reconstructed it, and worked it with a steam-engine of small power. In the hands of his engineer, a clever fellow, previously acquainted with machinery, together with a blacksmith, both guided by himself, the apparatus has undergone since that time a total revolution. The old cultivators have been abandoned for a larger one better adapted for light land, with 6 tines 5 feet wide, see Fig. A. It is raised and lowered very simply, works steadily, and has required no repair. One thing is yet wanting to perfect it, and this is easily supplied, namely, an arrangement by which the tine frame may be lowered when one wheel is upon the unbroken soil. The windlass is also home-made. Two drums fixed in a heavy frame, carried on wheels. A pully on either side receives motion from the engine by means of a band. No repairs have been needed by the machine since it was made. The snatch-blocks are from Messrs. Howards'; the porters are of his pattern, save that represented by Fig. C., used in the line of the fixed rope. B shows the fore-carriage, steerage, draft, chain, &c. with arms of "turning bow" at an angle of 45°. D shows the crank-axle. The steersman rides on a seat behind.

A

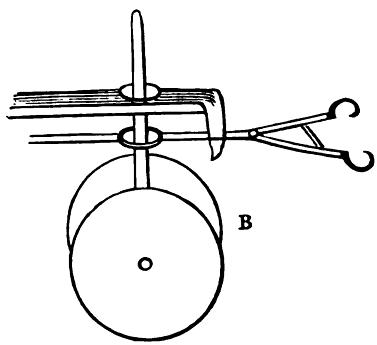


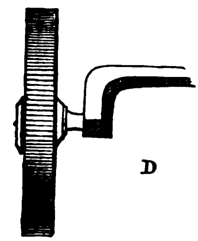
C



For some time Mr. Cooper was under the impression that he

could dispense with a plough, but he has since learned the value of it, and uses one of Fowler's 4-furrow ploughs, which he borrows





from his friend Mr. Greene. We had the good fortune to see the set of tackle at work, and were much pleased with the simplicity and strength of the parts. The engine made by Burrell is of 12-horse power, traction, and double cylinder. It was bought in 1861. When requested to state what was the cost of his apparatus, Mr. Cooper handed us the following:—

	£.	*s.*	*d.*	
Engine	400	0	0	
5 snatch-blocks from Messrs. Howard	12	10	0	
Rope (1600 yards)	80	0	0	subject to discount.
12 rope-porters, 15*s.*	9	0	0	made at home.
40 standard ditto, 7*s.* 6*d.*	15	0	0	"
1 cultivator	20	0	0	"
1 windlass	40	0	0	"
10 low porters	2	10	0	"
Extra snatch-blocks	7	10	0	"
8 anchors	8	0	0	"
Total	594	10	0	

N.B.—Coal, "Brights," price, by *contract*, 17*s.* per ton; consumption, 1 cwt. per acre.

Repairs, Renewals, and Wear and Tear.—The engine repairs, owing to the ability and foresight of the engine-driver, cannot be put at more than 5*l.* per annum, so we were assured. It was certainly in excellent condition. Quite half should be charged to thrashing, grinding, and other farm-work. As to rope, the last, from Glass, Elliott and Co., has lasted three seasons, and will last two more. The two first are reported to have been utterly worthless.

Work done.—During a day of 10 hours, including removals, 10 acres are broken up with cultivator. The stubbles are prepared for roots by being broken up; first, 5 inches deep, and then crossed 9 or 10 inches; the steam pressure being seldom above 60 lbs. The tackle is so judiciously worked, and the

land is so clean, that one sound operation is often made to take the place of two. The time is well chosen, the operator is careful as to the nature of the operation, and then throws his own impetus into men, horses, and tackle, and achieves the object in the best manner, the shortest time, and at the least cost. The cultivator is used generally, but all muck is ploughed in for roots and layers for wheat.

Cost of Work.—The engine-driver who receives 1*s.* 10*d.* an acre, distributes it generally as follows:—

	s.	*d.*
Engine-man	0	6
Windlass-man	0	2½
2 Anchor-men	0	5
Ploughman	0	3
1 water-cart boy and 4 porter-boys ..	0	5½
	1	10
Horse with water-cart	0	6
Coal	0	11
Oil	0	1½
Expenses per acre	3	4½

As some readers may like to see how a year's work looks on paper, we append a statement drawn up by Mr. Cooper, affecting the year 1864, for distribution amongst a few friends interested in steam culture. (See following page.)

The labour is paid at the uniform rate of 1*s.* 10*d.* per acre; the consumption of coal and oil of course varies with the time occupied in doing the work, but these are kept in stock and used only for the steam cultivation, they also are taken upon an average of the 731 acres. The horse with water-cart is omitted, and the horses employed in removals. An additional 3*d.* an acre (which under the peculiar circumstances seems sufficient), raises the total, as shown on next page, to 3*s.* 0¼*d.* an acre.

To pursue the calculation a little further, it is necessary to refer to the statement of Mr. Cooper's capital account. It will be seen that (with the omission of any charge for Fowler's plough borrowed) the annual charge for wear and tear, allowing half that of the engine for other services, amounts to 46*l.* 1*s.* 3*d.*, for interest 20*l.* 10*s.* 6*d.*, together 66*l.* 11*s.* 9*d.* This sum distributed over 731 acres (the year's work) gives 1*s.* 9¾*d.*, which, added to 3*s.* 0¼*d.*, the expense of labour, coal, oil, and horse, forms a total of 4*s.* 10*d.* an acre. But these figures may be looked at in another light. This sheet shows what steam has done. Suppose that the 12 horses displaced by steam would have done the same, what would have been the difference in the expense? We estimate that a farm-horse costs in attendance, food, wear and tear of implements, and harness, depreciation

PARTICULARS of STEAM CULTIVATION on the BOWBECK FARM, 1864, in the occupation of G. KERSEY COOPER.

Names of Fields.	Condition of Field.	Extent.	When begun.	When finished.	Depth of Cultivation.	Width of Cultivator.	Number of Persons engaged. Men.	Number of Persons engaged. Boys.	Cost for Labour.	Coals consumed at 20s. per Ton.	Oil consumed at 6s. per Gallon.	Total Cost for Labour, Coal, and Oil.	Remarks.
		Acres.			Inches.	Scarifier.	Men.	Boys.					SPRING CULTIVATION.
Stanton Breck	After Turnips, for Barley	30	Mar. 14	Mar. 18	9	4½-feet	5	5	Average cost per Acre, 1s. 10d.	Average cost per Acre, 9½d.	Average cost per Acre, 1½d.	Average cost per Acre, 2s. 9½d.	A common triangular Scarifier, 10 tines.
Mouse's Field	After Beet, for Barley	20	Mar. 19	Mar. 21	9	4½ ,,	5	5					Ditto (heavy land).
Stanton Field	After Wheat, for Beet-root	24	Mar. 22	Mar. 24	7	4½ ,,	5	5					Strong six tined cultivator (heavy land).
Dale Field	Ditto	19	Mar. 24	Mar. 28	7	4½ ,,	5	5					Ditto.
Stanton Field	Second Cultivation for Beet	24	Mar. 30	Apr. 1	9	4½ ,,	5	5					Ditto.
Dale Field	Ditto	19	Apr. 4	Apr. 6	9	4½ ,,	5	5					Ditto.
Holly Bush Piece	After Wheat for Beet and Swedes	23	Apr. 7	Apr. 8	8	4½ ,,	5	5					Ditto (mixed soiled lands).
Ditto	Second Cultivation	23	Apr. 22	Apr. 23	10	4½ ,,	5	5					Ditto.
Gant's Close	For Root after Bastard Layer	10	May 11	May 11	7	4½ ,,	5	5					With triangular Harrow behind Cultivator (light mixed soil).
Timpson's Breck	For Root after Rye Feed	44	May 12	May 16	7	4½ ,,	5	5					Ditto.
Ditto	Second Cultivation	44	May 18	May 21	9	4½ ,,	5	5					Ditto.
Gant's Close	For Root after Bastard Layer	12¾	May 24	May 24	7	4½ ,,	5	5					Ditto.
Lock Close	For Root after Feed Rye	22	May 27	May 28	7	4½ ,,	5	5					Ditto.
Foreman's Breck	For Root after Layer	12¼	May 31	June 2	7	4½ ,,	5	5					Ditto.
Lock Close	Second Cultivation	22	June 4	June 7	9	4½ ,,	5	5					Ditto.
Foreman's Breck	Ditto	12¼	June 10	June 11	9	4½ ,,	5	5					Ditto.
Part of Road Piece	For Root after Tares	8¼	June 18	June 18	7	4½ ,,	5	5					Ditto.
													AUTUMN CULTIVATION.
Part of Heath Piece	Wheat Stubble	17	Aug. 31	Sept. 1	6	4½ ,,	5	5					Six-tined Cultivator, with triangular Harrow.
Park Road Piece	Ditto	19	Sept. 2	Sept. 3	6	4½ ,,	5	5					Ditto.
Gospel Hill	Ditto	65	Sept. 5	Sept. 10	6	4½ ,,	5	5					Ditto.
Square	Ditto	42	Sept. 15	Sept. 19	6	4½ ,,	5	5					Six-tined Cultivator (showery, that Harrow was not attached).
Road Balls	Pea Stubble	11	Sept. 20	Sept. 20	6	4½ ,,	5	5					Ditto.
Brick-kiln Field	Barley Stubble	28	Sept. 22	Sept. 24	6	4½ ,,	5	5					Ditto.
First Footpath Field	Wheat Stubble	9	Sept. 26	Sept. 26	7	4½ ,,	5	5					Ditto (heavy land).
Bowbeck Field	Ditto	24	Sept. 27	Sept. 29	7	4½ ,,	5	5					Ditto.
Jordan's Field	Ditto	14	Sept. 30	Oct 1	7	4½ ,,	5	5					Ditto.
Stanton Breck	Barley Stubble	30	Oct. 3	Oct. 5	6	4½ ,,	5	5					Ditto.
Ditto	Second Cultivation	30	Oct. 6	Oct. 8	8	4½ ,,	5	5					Ditto.
Brick-kiln Field	Ditto	28	Oct. 11	Oct. 13	8	4½ ,,	5	5					Ditto.
Part of Gospel Hill	Ditto	33	Oct. 17	Oct. 19	7	4½ ,,	5	5					Ditto (light land).
Part of Heath Land	Ditto	11	Oct. 20	Oct. 20	9	4½ ,,	5	5					Ditto.

and interest, 46*l.* 13*s.* per annum. Assuming this to be fair, it will be found that horses would have done the work of the year 1864 (731 acres) at a cost of 560*l.*; steam would have done it at a cost of 184*l.* 2*s.* 10½*d.* Were every advantage to be pushed to the utmost, the comparison would be even more in favour of steam; but we are contented with an approximation to the truth.

Having reason to question the accuracy of our notes respecting the live stock, a note was forwarded to Mr. Cooper. Some extracts from his reply are here transcribed. "I find that I have increased the quantity of my sheep stock, but the great advantage to me has been holding on, or buying more sheep in the spring of the year when farmers find a difficulty in holding hoggets on flock farms. By cultivating in the autumn I can do this. The green cropping before roots which I can thus obtain enables me to carry a much larger stock of sheep at that profitable period than I otherwise could do. I certainly grow more roots, more corn, and make more money from the land than I have ever done before, besides always being at the head instead of at the tail of my work. You may speak of the general advantages which are felt in every branch of the detail of my success from the application of steam power to the land, in doing the work *when it ought to be done.*" He feels, in fact, that it improves the whole pace of a farm, deepens the interest of the men in their work, and impels them onward towards mental development. It may be remarked that although the price paid for labour is the same per acre, the earnings much depend on the depth of the operation and strength of the land, some days being high, the same with the consumption of coal and oil, the former varying from 1½ to 2½ cwts. per day.

No. 22. Lord Leconfield, Petworth Park, Sussex, September 25. His Lordship's vehicle met us at the station, drove us through the beautifully-undulating park, where herds of deer were feeding under the protecting arm of stately beech-trees, to the farm which lies at the extremity of the woods which skirt the park. There we were met by his Lordship's bailiff, Mr. Smith. The shades of evening were descending, and we were prevented from forming so close an acquaintance with the operations at Petworth as could have been desired. That part of the farm over which we walked we found in a high state of culture. The fields, formerly small, are now enlarged, and are naturally well supplied with water. The 4-course system of cropping is observed. The land is drained 4 feet deep 2 rods apart. There are 700 acres—500 acres of it are stiffish, requiring 2 horses to plough 3 roods 6 inches deep. Some will bear sheep feeding, some not. Considerable improvement is said to have taken place in the produce per acre, and in the texture of the clay staple,

which is due to drainage and deep culture. The fields are not well suited for steam culture, being very hilly, and the boulders near the surface. The statistics to be had were very few. His Lordship in 1861 bought a set of Fowler's tackle, later he bought a set of Howards', which was mainly for the use of his tenantry, who do not seem to avail themselves readily of the privilege. Mr. Smith expressed himself very strongly in favour of the round-about system on land so hilly as this. The difficulty in moving the heavy 14-horse power engine about he described as insuperable. Considering the steep inclines, the irregular fields, and the great boulders, he thought the fixed engine decidedly preferable. The farms, too, in the neighbourhood are very small.

Both sets of tackle include an engine; one of 14-horse power, one of 10-horse power. Fowler's cost 1000*l.*, Howards' cost 700*l.* in 1863, including one of Clayton and Shuttleworth's traction engines. The repairs, wear and tear of Fowler's are estimated roughly at 50*l.* a year. We had hoped to have received some particulars from another of his Lordship's agents who has charge of Howards' tackle, which is placed at the disposal of the tenantry, and which was said to have done more work than Fowler's. He has not, however, sent us the particulars up to the time of going to press. The work done with Howards' averages 5 acres per day with the plough, and 7 to 8 acres with the cultivator, including removals, which consume half a day each, and the work of 6 or 8 horses.

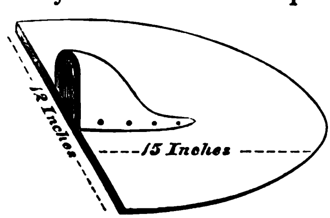
The cost of manual and horse labour, coals and oil, is 1*l.* 9*s.* 2*d.* per day. Fowler's tackle averages 5 acres per day ploughing 8 to 10 inches, 6 to 8 acres cultivating 10 to 12 inches, inclusive of removals; the cost being 1*l.* 10*s.* 10*d.* for manual and horse labour, coal, and oil. The ordinary weekly wage in the neighbourhood is 11*s.* or 12*s.* The coal costs from 22*s.* to 26*s.* per ton home; Fowler's engine consumes 10 cwt. while working with 60 lbs. steam pressure. An intelligent blacksmith is employed on the estate. Fowler's tackle was set out to work, but the weather had been all against it. We have seen a better use made of steam elsewhere, but the farm is not well adapted, in Mr. Smith's opinion, for Fowler's tackle. That the farm was in a fine state of cultivation was rather due to the liberal application of manure and the keeping of sheep. Mr. Smith stated that the chief obstacle in that neighbourhood to steam was the first cost of the apparatus, and the limited extent of the farms. Still he thought that Howards' apparatus might be added with great advantage to the farming machinery required for the cultivation of 300 acres, Fowler's for 500 acres. With respect to the advantage derived from working in large fields, we were assured that between breaking up a 30-acre field and a 9-acre field with Fowler's tackle, there was a difference of

one-third in time. He spoke, too, of the increased pace obtained throughout the farm, and the greater promptitude with which all tillage operations are performed.

No. 23. Messrs. R. and T. Wagstaff, Stifford Clays, Grays, Essex, September 3. These gentlemen occupy three farms, two belonging to Mr. Winfield Baker, lying together, and one at a distance of 4 miles, belonging to Mr. H. E. Gurney. This gives 1179 acres of arable, minus 149 acres of grass. Having business as potato salesmen at King's Cross and Spitalfields, they find it advantageous to pursue the market-garden system. The three farms consist of light, medium, and heavy soil, the prevailing character being loam upon gravel substratum, reposing upon chalk. They are thrown into blocks, and several engine-roads are constructed. In order to prepare the way for steam, and enlarge the fields which were small, about 4000*l.* was spent in making roads, grubbing hedgerows, and 1000*l.* in drainage, which has been done 9 yards apart, and 4 feet deep. The manual labour amounts to about 5000*l.* a-year. The horse-power is not reduced; but a greater number of horses are set free from the land to be employed in carting manure. There are 68 horses. This power is larger than would be required, in consequence of some of the land having come into occupation in a very foul condition. Great difficulty has been experienced in obtaining a supply of good water. A well specially sunk in the floor of the engine-house yields a water which leaves so large a deposit as to cause considerable expense in renewal of tubes and of fire-box too, since a new one will be needed next year. Cleaning out takes 3 hours twice a week. We suggested the use of Lefranc's fluid. The benefit here desired from steam was not so much depth of tillage as the power of creating a seed-bed in the shortest space of time. No sooner is one breadth of a crop cleared than the land must be broken up and planted. It followed that an apparatus was also wanted that could quickly be picked up, moved without horses, and quickly set down again. The one chosen may be taken up in half an hour, and set down ready for work in one hour. Mr. Wagstaff is quite satisfied with the efficient, in fact, the indispensable aid thus rendered him. He speaks in no undecided terms, too, of the increased value steam-tillage has conferred on the drainage works. On land so treated they are deterred from working by rain a less number of days than on any other. The land is now cultivated on the flat, and water-furrows, which used to cost annually on part of the land "nearly as much as the parochial rates," are abandoned. Not a pint of water stands upon the land after the heaviest rain. With respect, too, to increased produce, he testifies to the greater bulk of all green crops, and to one-quarter per acre of wheat in excess of what was customary, as due to the employment of steam.

The *Apparatus*, bought of Messrs. Coleman and Morton of Chelmsford, in 1862 (the first set on this system offered to the public), consists of an *Engine* of 10-horse power, double cylinder, traction, manufactured by Messrs. Clayton and Shuttleworth; two of Coleman's *Cultivators*, 1200 yards of *rope*, and rope-porters: the total price 640*l.* Finding it necessary to have a plough, Mr. Wagstaff has ordered one, together with an anchor, from the Leeds Works. The reason assigned was that the weather often being unfavourable after harvest, he could continue work later into the autumn, and commence it earlier in the spring, by means of a plough.

Repairs, Renewals, Wear and Tear.—The repairs of the 3 years average 20*l.* a-year. This nearly all concentrates, however, in the first year, which, being highly experimental, was characterised by a series of breakages. The set bought was the first on this system offered to the public. The last two years have been without a mishap. The repairs are less than they would be were there no smith and smith's shop on the premises. We observed the smith making a very excellent share from wrought-steel plate and wrought-iron socket rivetted together. This forms a cheap and effective share.



Work done.—During a day of 10 hours, 7 acres a-day with cultivators, 5 to 9 inches deep, including removals. The amount of work done is not great; there seems to be too many horses to allow of that. Last year (1865) it amounted to 150 acres, but the autumn was unfavourable. Up to the time of our visit, 105 acres had been broken up, and it was proposed to break up 200 more before October, weather permitting.

Cost of Working.

	£.	s.	d.
Manual and horse-labour per day:—			
1 engine-man	0	5	0
3 men, 2*s.* 4*d.*	0	7	0
1 man	0	2	8
2 boys	0	2	0
Water-cart, boy and horse	0	3	8
Coal	0	10	0
Oil	0	1	0
	1	11	4
Interest and maintenance on 500*l.*, as in other cases	3	11	3*
Repairs, 20*l.* per annum	0	19	0
Or a total cost of	6	1	7

which, distributed over 7 acres, gives 17*s.* 4*d.* an acre.

* The tenant approves of 2*l.* per day as the charge for interest and maintenance.

The *coal* used is "Hartley's," price 20*s.* per ton home; consumption, 10 cwts. per day of 10 hours; 7 cwts. only when under cover and stationary.

We found the tackle at work. When questioned as to the advantage of the direct pull of the implement to the engine characteristic of this plan, Mr. Wagstaff appeared to attach less importance to this than to the facility possessed for moving about from field to field without assistance from horses.

REPORTS OF VISITS TO SECTION C.—LIGHT-LAND FARMS.

No. 24. On the 5th of September, after a day's heavy rain, we visited the farm of Messrs. Blyth and Squier, known as the Mucking Heath Farm, at Stanford-le-Hope in Essex. Mucking is just on the edge of the London Clay formation. It occupies the rising ground which overlooks the bend of the river Thames below Tilbury. The soil, however, which gives birth to furze and fern, has nothing of the character of clay, but belongs rather to the drift or the Barton and Bagshot series of Post-tertiary sands. Suffice it to say that a pair of horses makes easy work of a furrow 6 inches deep, that artificial drainage is nowhere requisite, and that in some fields difficulty is experienced in consolidating the soil. This farm, the property of Mr. Cox, consists of 400 acres under the plough. It was taken in 1860 for the purpose of being tilled by steam power. The tenants, who possessed several thrashing-machines, for which they found work in the neighbourhood, thought that they might unite with their other business the kindred one of contracting for steam tillage. They consequently purchased two sets of tackle; one of Messrs. Fowler of Leeds, another of Messrs. J. and F. Howard of Bedford. The first two years these two sets were so thoroughly employed on their own farms, that they could not spare them for contract work. Subsequently they have been disappointed in the number of applications made for their hire. Fowler's tackle has during the last three or four years sufficed for their purpose, and being better suited, as they say, to their special circumstances, they have put Howard's on one side. Their own experience, however, of the expenses of this mode of tillage, and the want of desire to employ steam in the neighbourhood, has disinclined them to purchase another and more improved set of Fowler's tackle, which they would have done had the results of the present set justified the investment.

A great deal has been done in preparing for the steam plough. The tenants obtained permission of the landlord to remove the fences, to grub up the wood and heath, and to lay out the plot into blocks (the greatest stretch being 825 yards),

which can be readily ploughed from the various roads that divide them and cut one another nearly at right angles. This work has cost 700*l.*, but the removal of the hedges is equivalent to the gain of 10 acres for which rent formerly was paid. A great portion of the outlay was made in reclaiming the heath and fox cover, which had not paid rent.

The soil, which is thin, and mainly the result of vegetable decay, lies upon a gravel subsoil, which, allowing the water to percolate freely, admits of the closing of every open ditch which previously existed.

The water is obtained partly from ponds and partly by means of 5 wells sunk at various parts of the farm to a depth of 50 feet.

We have already stated that in 1860 both Howard's and Fowler's sets of tackle were purchased and worked vigorously for two seasons. During the third and subsequent seasons one apparatus alone has been used. In conjunction with steam, 8 horses have been employed. United they have wrought a change in about two years which, if left to the 14 horses that are considered sufficient to work a farm of this size, would have required fully 7 years, and then have been done less effectively. The two sets consist of the following members.

Fowler's.—A 10-horse power Engine manufactured by Clayton and Shuttleworth, a 4-furrow plough, used as a plough and digger, 800 yards of rope; cost, 700*l.*

Howard's.—A Cultivator, 1600 yards of rope, windlass, porters, &c.; cost, 200*l.*

The cultivator and windlass of this set is considered too light. It appeared to have been much strained: but the rope was in excellent condition.

Repairs, Renewals, and Wear and Tear of Fowler's tackle will chiefly be gathered from the annexed summary. The repairs are averaged at 100*l.* a year. The rope is estimated to cost 1*s.* per acre; ploughshares, and other wearing parts, 1*s.* per acre.

The Work done per day of 10 hours, cultivating from 3 to 4 acres 8 to 12 inches deep, including removals.

Farm Account.

FOWLER.

	Acres.		s.		£.	s.	d.
1860 ..	138	at	10	..	69	0	0
1861 ..	663	,,	14	..	468	8	0
1862 ..	182	,,	15	..	115	10	0
1863 ..	83	,,	12	..	58	18	0
1864 ..	33	,,	15	..	95	16	0
1865	0	,,	..	..	30	0	0
	289				837	12	0

HOWARD.

	Acres.		s.		£.	s.	d.
1861 ..	179	at	8	..	71	10	0
1862 ..	193	,,	8	..	77	14	0
1863 ..	83	,,	10	..	41	10	0
1864							
	455				190	14	0

Now that the lands have been cleared and got into working order, it is found that about a moiety (200 acres) comes in rotation to be deeply stirred each year, viz.:—

Acres.	
100	stubbles in autumn, immediately after harvest.
50	„ in early spring for roots, potatoes, mangel, and kohl rabi.
50	„ after tares, rye, trifolium, clover, &c., for rape and turnips.
200	

Any variation from the ordinary rotation, wherein 2 corn crops are taken in succession, as an equivalent for 2 years' layers, will require about the same tillages.

The General Account (see pp. 164-165) differs from the above inasmuch as it embraces work done on neighbouring farms. The Farm, it will be seen, is charged from the same scale of prices as applies to land where work is done for hire.

Cost of Work done.

Manual labour per day:—	s.	d.
Engine-man	3	6
Anchor-man	2	0
2 porter-boys	2	0
Ploughman..	2	6
	10	0

1s. per acre is divided amongst the company by way of incentive.

The coals burned are "Hartley's," which cost 18s. a ton home. The quantity burned per day of 10 hours is ½ a ton—the cost consequently 9s. Add to this the oil, 1s. per day, and the daily expenses are found to amount to 20s.* For a general view of the cost of the work done on and off the farm, we must refer to the Farm Account and the Summary appended. From the latter it will be seen that for Fowler's Apparatus the disbursements from 1860 to 1865 amounted to 1673*l.* 7*s.* 6*d.*, the returns to 1228*l.* 6*s.*, so that a balance of 445*l.* 1*s.* 6*d.* appears against Steam; in Howard's case the balance in the same direction is 237*l.* 13*s.* 5*d.* In neither case does interest on capital figure in the account.

The expenses of working have been thus estimated over an area of 280 acres during 60 days, ploughed from 8 to 12 inches deep.

	Per Acre. s.	d.
Wages	3	6
Irons and water	1	6
Coals and oil	2	6
Repairs, maintenance of apparatus and rope ..	3	6
	11	0

* This is exclusive of the 1s. per acre gratuity.

FOWLER'S STEAM

COPY OF SUMMARY.—

	PAYMENTS.	Say, per Acre. s. d.	£. s. d.	£. s. d.
1860	Cost of Engine and Tackle:—			
	10-horse Engine, Plough, Anchor, &c. ..	..	700 0 0	
	Cash paid for Repairs and Labour	5 6	81 18 0	
				781 18 0
1861	Cash paid for Labour	3 7	128 16 4	
	,, Repairs and New Plough ..	4 2	146 16 4	
				275 12 8
1862	Cash paid for Labour	4 0	72 17 0	
	,, Repairs	3 4	61 4 0	
	,, Hire of Engine, 90 days, at 20s.	5 0	90 0 0	
				224 1 2
1863	Cash paid for Labour	4 4	36 14 0	
	,, Repairs	6 4	54 8 2	
	,, Hire of Engine, 46 days, at 20s.	5 6	46 0 0	
				137 2 2
1864	Cash paid for Labour	3 8	36 16 6	
	,, Repairs and Clip-drum, &c. ..	13 0	130 4 9	
	,, Hire of Engine, 60 days, at 20s.	6 0	60 0 0	
				227 1 3
1865	Cash paid for Labour	3 3	6 5 9	
	,, Repairs	4 6	9 6 6	
	,, Hire of Engine	4 3	12 0 0	
				27 12 3
	Total Payments	..	..	1673 7 6
	Total Receipts	..	..	1228 6 0
	Balance	..	..	445 1 6

HOWARD'S CULTIVATING

		Per Acre. s. d.	£. s. d.	£. s. d.
1861	Cost of Tackle (without Engine)	..	200 0 0	
	Cash paid for Labour and Repairs	4 4	79 19 0	
	,, Repairs	..	7 0 0	
	,, Hire of Engine, 90 days, at 15s.	3 9	67 10 0	
				354 9 0
1862	Cash paid for Labour	4 0	80 16 1	
	,, Repairs	3 0	59 14 5	
	,, Hire of Engine	3 3	60 16 0	
				201 6 6
·3	Cash paid for Labour	4 0	21 12 4	
	,, Repairs	2 0	10 9 4	
	,, Hire of Engine	5 0	27 0 0	
				59 1 8
	Total Payments	..	..	614 17 2
	Total Receipts	..	..	377 4 0
	Balance	..	..	237 13 2

CULTIVATION ACCOUNT.

(*Messrs. Blyth and Squier, No.* 24).

	RECEIPTS.			Per Day.	Per Acre.	
					s. d.	£. s.
1860	Cultivating	311 acres	in 93 days	3¼	12 0	188 18
1861	,,	713 ,,	,, 175 ,,	4	14 3	508 2
1862	,,	368 ,,	,, 90 ,,	4	13 6	247 18
1863	,,	167 ,,	,, 46 ,,	3½	13 3	110 14
1864	,,	200 ,,	,, 60 ,,	3⅓	14 0	142 14
1865	,,	40 ,,	,, 14 ,,	3	15 0	30 0
	Total ..	1799 acres	478 days	3¾	14 0	1228 6

TACKLE ACCOUNT.

				Per Day.	Per Acre.	
					s. d.	£. s.
1861	Cultivating	370 acres	in 72 days	5	8 0	150 12
1862	,,	400 ,,	,, 87 ,,	4½	8 3	168 8
1863	,,	111 ,,	,, 36 ,,	3	10 6	58 4
	Total ..	881 acres	195 days	4½	8 6	377 4

From their experience, Messrs. B. and S. affirm such work as the above, if done by horses, would have cost from 14*s.* to 16*s.* per acre. On first entering the farm they were obliged to purchase every particle of horse keep, and their books show that each horse cost 15*s.* a week.

The reader will at once exclaim at the small amount of work done. He will object, with ourselves: "Here is light land, advantageously laid out in large plots, with straight boundaries, good engine roads, a good water supply, a liberal scale of wages with an additional piece-work inducement to the workmen, owners well acquainted with machinery, provided with a good staff of engineers and admirable workshops, wherein all repairs can be effected—why is it that the result is so disproportionate to the advantages? The tenants offer no explanation, they merely hand in the account. They surmise that the engine should be of 14-horse power instead of 10-horse power; but from what we saw, the implement working at a 10-inch minimum depth in wheat stubbles, did not appear to be doing more than 6 horses would master. The registered steam pressure was 80 lbs.

Notwithstanding this showing, these gentlemen lean decidedly to the adoption of steam in preference to horse cultivation. "Against this outlay," they say, "we have to balance such advantages as these: the saving of one-third horse power, the deepening of the staple, the getting rid of weeds, which have almost disappeared, the doing this at a time when it could not have been done by horses, the improved cultivation generally, the increased facilities afforded for a better and more frequent cultivation of fallow crops, both in spring and autumn. This extra tillage has been mostly given to the valley or deeper staple fields, which return as much for tillage as the higher and thinner soils do for manure. On deeply cultivated land manure appears to produce the greatest results. Steam enables Messrs. B. and S. to obtain an extra crop, potatoes or peas (both early) for the London market, before turnips. The despatch essential to this operation is only to be attained by the employment of steam. The farm appeared to great advantage. Cleanliness prevailed throughout, the root crops were beyond an average, and the stubbles gave indications of strong crops. Since our last visit, a 14-horse-power engine has been purchased.

No. 25. On the 7th September we visited Lodge Farm, in the parish of Higham, Suffolk. This farm, occupied by Mr. E. FYSON, is similar in character to those farms in Norfolk of which Mr. Hardley said, that they "might be ploughed with a pair of rabbits and a clasp-knife." It consists of 950 acres, 16 of which are in grass. It is situated on an exposed, undulating chalk range. The fields are very large, and the staple thin and

stony, a stratum of thin, hungry marl intervening between it and the chalk. Drainage is not required; and it is difficult to procure water, no special provision having been made for its supply. Two men and carts are usually employed to fetch it. This farm, which has been many years in the family, is the property of Mr. Barclay of Lombard-street, who has given every encouragement he could to the employment of steam. The tenant has been enterprising and skilful in the use of it; but he has not produced such results as he would do if the implements supplied were better adapted to the character of the land. He follows the four-course system of cropping; and in doing so says that the main advantages he derives from steam are, that the fallowing for roots is less expensive; the root-crop is more certain and much heavier by virtue of its being sown at the proper time; and the number of horses is reduced. Although he had very few statistics to offer, he affirmed that on no account would he farm without steam. What he had done convinced him, without going accurately into figures, that he must be a gainer. If more roots—that is to say, more sheep-feed—are obtained, there must on such land be more corn grown. The horses, formerly twenty-four, are now nineteen in number—two to 98 acres. The average amount of stock kept is 600 ewes and 40 beasts. For land of such weak texture the roots were very good; and the stubbles showed that the corn-crops were better than crops generally grown on similar soil. The land was clean, and throughout well farmed, without much dependence upon artificial manure.

The Apparatus (Fowler's) was purchased Christmas, 1862. Its parts are, an engine of 10-horse power, double cylinder, traction, manufactured by Messrs. Clayton and Shuttleworth for a gentleman who ordered it for estate-work. It was converted at Leeds. Two-thirds of its time it is engaged in thrashing, grinding, and chaff-cutting. It is driven by a labourer from the farm—a 4-furrow plough, a cultivator with 7 tines, an anchor, porters, and 800 yards of rope. Having been used one year, it was bought for 600*l.*

Repairs, Renewals, Wear and Tear.—The *Engine*, which is in excellent condition, has caused very little expense. The travelling-gear and one axletree and a clip-drum have been renewed. The *implements* have needed no repair, and are in good state. The *anchor* is also in nice keeping. The shares, on such sharp land, wear considerably; but not more than they would do by horse-power. The *rope*, having been well kept and carefully supported, is in excellent repair; the stress on it has never been great, though it might suffer from wear.

The Work done, and mode of Working.—The engine, with a

steam pressure of from 70 to 80 lbs., in a day of 10 hours, ploughs 8 acres 5 or 6 inches deep, and cultivates from 10 to 15 acres, 8 or 9 inches deep, with harrow following; the removals, which occupy 2 hours, being included. No actual account of work done is kept; Mr. Fyson estimates it at about 100 acres per year twice over. The preparation for roots is as follows: 1st. The stubble is broken up by the cultivator, with harrow attached; in the space of two weeks the field is crossed with these same implements. It is so left till spring, when a seed-furrow is turned by horse-power. All clover-leys are ploughed by steam as well as they can be done by horses.

The Cost of Work.

	Per Day. £.	s.	d.
Manual labour:—			
Engine-man	0	2	6
Ploughman	0	2	6
Anchor-man	0	2	0
2 boys	0	2	0
Water-cart, boy and horse	0	5	0
	0	14	0
Oil	0	2	0
Coals	0	11	7½
	1	7	7½

N.B.—No piecework payment.

The coal used is known as "Staveley Hards," 16*s.* 6*d.* per ton home, about 15 cwts. being used per day of 10 hours. The mud-holes of the engine are cleared out once a week.

No. 26. Mr. Edward Greene, the member for Bury St. Edmunds, eighteen months ago took the farm of 400 acres, near that town, which we visited September 8th. The soil is a good friable loam on a chalky subsoil, well suited for the growth of roots. The fields, which lie on each side the turnpike road, are large; they are bounded by straight fences, which are without timber. There is a partial supply of water from ponds; the greater part has to be carted an average of three-quarters of a mile. The farm requires no drainage. When entered, the farm was exceedingly foul: already (since November, 1865) a change has been wrought, which is due to steam-power, and could have resulted from no other in so short a time. A decided, vigilant man, who professes to "farm on the gallop," when he employs steam-power, will scarcely be satisfied with less than steam-pace. Mr. Greene farms on the four-course system, and intends to keep to it. If farmed so high for roots as to throw down the barley-crops he believes it possible to stiffen the straw with salt.

The *Apparatus*, purchased November, 1865, consists of an

	£.
Engine, 12-horse power, double cylinder, traction, made by Burrell of Thetford. It is used for thrashing and chaff-cutting. It is powerful and well made. The hind travelling wheels are 6 feet in diameter, and 12 inches across the tire. It drives the windlass with spindle and universal joint. Cost	400
Windlass and Rope Porters, made by Howard .. .. }	
Cultivator, Mr. Kersey Cooper's design, made by Burrell .. .. .. }	350
Three-furrow *Plough*, by Ransome. *Rope*, 1600 yards .. .. .. }	
Total	750

Of *Repairs*, &c., there has been no separate account kept.

Work done, and mode of doing it.—During a day of 10 hours, including removals, which occupy 2 hours, ploughing is done at the rate of 7 to 8 acres a day; and cultivating at about 10 acres a day, the first operation being 5 inches, the second 9 inches in depth. When days are long it is very usual to keep the engine running from 5 A.M. to 7 P.M. The steam-plough is used only to turn the wheat-furrow, or to put in long manure for roots. Since November, 1865, 315 acres have been ploughed or cultivated once over.

The Cost of Work.—The men are paid by the piece. The four principals take the job at 1*s.* 10*d.* per acre, the men spending their own time about moving, the master finding the horse to draw the water-cart. The payment of manual labour is thus arranged:—

	Per Acre. *s.*	*d.*	*s.*	*d.*
Engine-man	0	6		
Windlass-man	0	3		
Ploughman	0	3½		
2 anchor-men	0	5		
Porter-boys	0	3		
Water-boy	0	1½		
			1	10
Coals	1	0		
Oil	0	1½		
Carting water	0	4		
Interest	1	6		
Removals by horses	0	1½		
			3	1
			4	11

Mr. Greene's mode of estimating the expenses—wear and tear, repairs, maintenance, and interest—is as follows. The total cost of the apparatus being 750*l.*, half the cost of the engine and all that of the apparatus—viz., 550*l.*—are set down to tillage operations, thus—

	£.	*s.*
Repairs, wear and tear, and maintenance, on 550*l.* at 20 per cent.	110	0
Interest at 5 per cent. on 550*l.*	27	10
	137	10

The horses are reduced from ten to six. In harvest, a couple of light ones are bought to help through with carting, and sold again when it is done. If the land were heavier, Mr. Greene would certainly have a double-engine set of tackle.

No. 27. Mr. Smythe, resident at Newsells Bury, near Royston, in the county of Herts, received us Sept. 19. The farm consists of 700 acres of arable land, and 50 of grass, lying together, and extending over an undulating surface abounding with steep inclines. The fields are open and large, with scarcely a break or a hedge. Of these 700 acres 550 are suited to grow turnips, 100 are mixed soil and weak clay, and 50 are of a medium character. The stiffest lands, which are found on the summits of the hills, are said to require three horses to plough 5 inches deep; the light land below is easily ploughed with two. The subsoil of the upper field is clay upon chalk; of the lower, gravel upon chalk. The supply of water is a matter of difficulty. A necessity exists to husband water. The natural ponds, together with the wells and tanks which have been constructed, have frequently all been exhausted when steam tillage would prove most serviceable. It is then necessary to fetch water from a distance of 3 miles. This water leaves a great deposit in the boiler, which renders it desirable for the mud-holes to be cleaned out once in 12 days. When steam was introduced, the horses were reduced from 2½ per 100 acres (the usual number in the neighbourhood) to 2 horses, and then their work became lighter. The tenant's course of cropping varies with the quality of the land, as he is not restricted to the four-course shift. He believes that those who spend money liberally in machinery and manure should be trusted to farm as they please. Steam has enabled him to take a crop of beans when he could not have done so without it: thus, on the 100 acres of heavy soil, the rotation he intends to follow is—fallow, beans, wheat, seeds, oats. On the 550 acres of turnip soil the four-course system does prevail; 50 acres of the heavier land are laid down with sainfoin, which remains 4 years. The 100 acres of stiffish clay are divided into four plots, and tilled for wheat and dead fallow. By deepening the staple Mr. Smythe finds that his crops are increased, particularly the roots. This circumstance allows him to feed more sheep.

When we arrived the finishing stroke was being put to harvest. Two grain mowing-machines were at work on a late piece of barley. Nothing was being done with the steam-tackle. There were two reasons for this—wet weather and want of labour. Except during the first year or two of its possession, Mr. Smythe has not been able, for want of labour, to work the steam-tackle in harvest-time. This harvest he opened with 360 acres of corn

to be cut, and only twelve men to cut it. Wherever it is therefore, he substitutes machinery and horse-power for a fact which accounts for the small reduction made ... Men, however, cannot be dispensed with in steam cultiva and their absence, when most required, impairs its useful Mr. Smythe, in confirmation of these statements, assure that for nine months in the year his payment for labour doe exceed 11*l.* a week.

The *Apparatus* may be called Smith's. It was bought in 1 and consisted of

	£.
An *Engine* of 8-horse power, single cylinder, made by Messrs. Hornsby, which having been in use upon the farm since 1857 was charged to the steam cultivating apparatus	100
Windlass, 2 implements, 1400 yards rope and porters	255
Three-furrow plough, made by Howard, new 1862	54
	410

Being satisfied that the strain is less, and fewer breakag implements and rope occur, when the spasmodic action feeble engine is avoided, Mr. Smythe determined to chang 8-horse power, which had been two years in use when purch by him, for an engine of 10-horse power. The old en having been stayed and strengthened, was restored to its fo value (100*l.*), and passed, with a cheque for 50*l.*, in exchang the greater power. This addition, in 1865, increases the outlay of 1860 to 460*l.* 0*s.* 6*d.*

Repairs, Renewals, Wear and Tear.—From first to last—is, in 8 years—the original *engine* cost 100*l.*, or 12*l.* 10*s.* a Putting half the year's cost against steam cultivation (6*l* × 5 years), we have 31*l.* 5*s.*

The second engine has needed no repairs. The implem and windlass have cost little or nothing, save for wearing p of which no account has been kept.

The *Rope.*—A renewal of 1000 yards of steel-rope took in 1863, and of 1000 yards in 1864, together costing 80*l.* T ropes have been supplied by Messrs. Glass, Elliot, and Co., are of excellent quality. The first rope was very inferior.

Work done and mode of doing it during a day of 10 *hours, includi Removals.*

Ploughing 5 acres 5 inches deep.
Cultivating (3 tines) 5 acres 6 inches; heavy land, 10 inches.
Cultivating (5 tines) 10 acres 8 inches; heavy land, 13 inches, 2nd time

Previous to 1862, wheat-stubbles were broken up at o tion, and left for wintry influences till spring, wl ... crossed. Since 1862 they have been ploughed, ... by

or horses, and crossed, in spring, at one operation by steam. To this method, which produces a superior tilth, Mr. Smythe attributes his escape from the turnip-fly which ravages the crops around. Steam, by this showing, seems to have done away with the four operations, which are supposed throughout the country to be necessary to the perfection of fallows. The roots are grown with artificial manure only, and good tillage.

Cost of Work.

	£.	s.	d.
Engine-man	0	1	10
Extra	0	1	0
1 ploughman	0	1	10
Extra	0	1	0
1 windlass	0	1	10
2 anchor	0	3	8
2 boys	0	1	4
1 boy, horse, cart	0	4	6
1 boy to oil rollers	0	0	4
	0	17	4
Coal, 7 cwts.	0	6	3¼
Oil	0	0	9
Total cost per day	1	4	4¼

N.B.—These 2 men receive 1*s*. a-day extra when the engine is working, All men receive 2 pints of beer a-day. The average wages of a day labourer, 1*s*. 10*d*. *Coal*—"Staveley Hards," 18*s*. per ton home, 7 cwts. used per day of 10 hours.

Our walk over the farm satisfied us as to its good management, and our inspection of the tackle of its good keeping. However, the engine and tackle were found abroad. The man who has charge of the engine was formerly a common labourer. There is no smith's shop. Mr. Smythe expressed himself as perfectly satisfied with the results of steam-tillage, and would on no account attempt to farm without steam-power. He says, "Deep cultivation has improved the drainage on my stronger soils, which are drained 3 feet deep 8 yards apart." The number of sheep has been increased on this farm since steam was introduced from 600 to about 800.

No. 28. The name of Ellman is well known in the county of Sussex; it stands associated with progressive movements in agriculture, and especially with the annals of sheep-farming. We were received on the 24th September by Mr. R. H. Ellman, of Lamport, and became acquainted with the 1300 acres of land which he occupies under Lord Abergavenny, on the bleak chalk lowns which lie to the north-west of Lewes. The hill-sides are generally steep; in some cases too steep for cultivation. The cultivated area comprises 500 acres; on the rest, a fine flock of

800 Down ewes are pastured, being folded at night. The arable land is a marl upon chalk; it requires no drainage, and can be worked with 2 horses when thoroughly dry, though sometimes 3 are used. The fields, which vary from 30 to 40 acres, are divided by turf borders and much intersected by foot-paths; there are no hedges. The Earl gives his consent to such improvements as the tenant chooses to make to facilitate the use of steam; but the engine is without a shed, and the buildings are in that state which is well described by Lord Palmerston's term "ramshackle." The water-supply would be difficult, were it not for the Water Company which supplies the town. The payment of 3*l.* annually secures the right of drawing from the main, which is within a mile of most parts of the arable portion of the farm, any quantity of excellent water. At full work the quantity used is 800 or 900 gallons per day, which at the Lewes rate would cost 5*s.* 6*d.*

The Course of Cropping.—On 61 acres of the stiffest land, wheat alternates each year with a green crop; if possible, and possible only by the use of steam, with *two* green crops. All green meat finds a ready sale in Lewes. 308 acres of milder land is thus cropped:—Wheat, oats, green crop. The remainder is being brought in to a course wherein two green crops are followed by a straw crop, the straw crop occurring once in three years. The former course of cropping was oats, green crops, wheat.

Beyond the advantages apparent from these changes, to compass which steam was introduced, the labour of 20 oxen and 2 horses —equivalent to that of 12 horses—has been dispensed with; whilst all the operations of the farm have been quickened, for this always follows. The horses now are 14 in number (about 2 to 70 acres of arable land).

The Apparatus (Fowler's) was bought December, 1864. The engine, 14-horse power, with double cylinder, traction, was made by Burrell of Thetford, and is used for thrashing at home and abroad (550*l.*), chaff-cutting, and contract-ploughing; also a 4-furrow plough, 1 scarifier, 800 yards of rope, anchor, porters, &c., costing altogether 875*l.* Subsequent addition — 1 cultivator, &c., cost 70*l.*; total, 945*l.*

The Repairs, Renewals, Wear and Tear.—The sharp flinty nature of the soil and the steep inclines cause much wear of rope, rope-porters, and shares. Most of the repairs rest upon these parts of the apparatus, not omitting the anchor. Judging from his present experience, Mr. Ellman considers that 15 per cent. charged upon the outlay would cover these expenses, and also serve for the perfect maintenance of the entire machinery:—

	£.	s.	d.
For the two years the general expenses have been ..	244	17	7
" engineering expenses	183	7	2
	428	4	9
15*l.* per cent. upon 875*l.* would be for two years.. ..	262	10	0

He has furnished us with the following account of outlays to be charged to his cultivating expenses only:—

		£.	s.	d.
1865—Carriage of ironwork		16	6	6
Burrell's and other smiths' bills		96	14	8
Sundry small payments		1	0	0
		114	1	2
Coals	£70 0 0			
Wages	125 0 0			
		195	0	0
		309	1	2
1866—Carriage of ironwork		2	17	10
Burrell's and other smiths' bills (500 yards new rope included)		138	4	3
Sundry small payments		4	0	0
		145	2	1
Coals	£50 0 0			
Wages	125 0 0			
		175	0	0
		320	2	1

Fifteen per cent. upon two-thirds cost of engine (550*l.*) and whole cost of apparatus (395*l.*), together 761*l.*, would amount to 114*l.* 3*s.*

There is a visible discrepancy here, which can only be accounted for by supposing—and we believe we are correct in doing so—that the engineering expenses, to a considerable extent, represent expenses that should figure in the original outlay. These would certainly not occur again. The general expenses include a variety of duplicates, and a very large store of coals.

Work Done.—During a day of 10 hours, removals included:—

Ploughing 6 acres	7 to 10 inches.
Scarifying 12 acres	12 inches.

Work done at home, and for hire, in 1865, ploughing once or scarifying twice, 666 acres, grubbing 25 twice over, 50 acres; 1866, plougning once or scarifying twice, 684 acres.

The price charged for contract-work is 20*s.* per acre on heavy land, and from 13*s.* to 16*s.* on light land, for ploughing once, or cultivating twice.

Manual Labour.—Engine-man, 3*s.* 4*d.*; ploughman, 2*s.* 2*d.*;

anchor-man, 1*s.* 8*d.*; two porter-boys, 3*s.*; boy, horse and cart, 5*s.* = 15*s.* 2*d.* The driver and ploughman have 6*d.* per acre between them extra, making 15*s.* 8*d.*

Add to this, 12 cwts. of coal consumed in 10 hours, 9*s.* (Staffordshire, 16*s.* per ton home), and oil, 1*s.*; total 1*l.* 5*s.* 8d. per day. Add 15 per cent. for wear and tear, and 5 per cent. upon 761*l.*, and the cost per acre is

	Ploughing.		Cultivating.	
	s.	*d.*	*s.*	*d.*
For manual labour, carting water, coal and oil ..	4	3¼	2	1½
Wear and tear, maintenance and interest	4	4¼	4	4¼
	8	7½	6	5¾

A pair of horses or 4 bullocks, with one or two attendants, laboriously turning over an acre 5 or 6 inches deep, during a day of 8 hours, can scarcely be compared in point of economy with machinery that can be worked to such advantage. It is fair to state Mr. Ellman's opinion that contract-work, at the price he has charged, does not pay so well as the price he receives for thrashing wheat at 1*s.* 4*d.* and oats 1*s.*

It only remains for us to say that labour is plentiful, that the wages per day-work is 2*s.* 4*d.*, that the engine-driver is a trained mechanist; but that there was neither smith nor smith's shop on the premises.

It is to diminished expenditure and deeper culture that Mr. Ellman can at present point. He considers it too early to say anything about increased produce. On this point he hopes eventually to speak very decidedly. The apparatus was not at work, nor did we see it.

No. 29. On Friday, the 21st September, we visited Mr. J. Arnot's farm at Carshalton, in the county of Surrey. It consists of 600 acres of land, nearly all under the plough. It lies in large fields, divested of hedge-rows and hedge-row timber, is fairly and naturally supplied with good water, and in farming it Mr. Arnot is under no restrictions. In satisfaction of the demand of the London market it is cropped under various shifts: 370 acres are under the 7-course shift—potatoes, wheat, oats or barley, green-rye, peas, or tares with a following crop, barley, seeds, wheat: 130 acres are under the 6-course shift—potatoes, wheat, mangolds, wheat, seeds, wheat: 90 acres, under the 4-course shift, lie at some distance and are worked for sheep. The soil, which varies in depth from 6 inches to 6 feet, is not drained, and under all circumstances can be ploughed with 2 horses. The horse-power is reduced from 18 to 9; 2 horses to 132 acres, instead of 66 acres. The steam-tackle was purchased in 1859. A knacker's horse is bought for 7*l.* or 8*l.* for harvest.

The Apparatus (Fowler's) consists of a traction engine of 10-horse power, double cylinder, manufactured by Clayton and

Shuttleworth, which is used for thrashing and other work, a 4-furrow plough, a 7-tine scarifier, anchor, porters, and 800 yards of rope: value, 881*l.* This sum includes a thrashing-machine.

Repairs, Renewals, Wear and Tear.—These were never heavy, and of late they have been very small. In looking over the accounts and vouchers for five years, it was discovered that, together with maintenance, they would amount to an annual charge of 15 per cent. The special account for *rope* stands thus:—Beside the original 800 yards in 1859 there have been supplied 400 yds. in September, 1861, and 300 yds. in March, 1862; 800 yds. have virtually disappeared, the remaining 700 are half worn out; but it is worth observing the time and duty through which the ropes of 1861 and 1862 have carried the purchaser. In point of quality, Mr. Arnot says they are twice as good as that of 1859. The wear of rope thus entails a cost of 126*l.* The repairs of the *engine* are under 5*l.* per year. A drag-harrow has been added to the tackle. We were unable to see either the engine or the implements; but were assured that they were in an efficient state.

Work Done and Mode of Working.—Per day of 10 hours, including removals: *ploughing* 6 acres, 9 inches deep, *cultivating* 10 acres about the same depth. He began by ploughing 13 in., but soon repented of what proved to be an error upon his sandy loam. The mode of preparing for the various crops is as follows:—For roots, if weedy, the wheat-stubble having been broken up in September, is scarified and harrowed by horse-power; and when the rubbish has been well weathered, it is readily turned down by steam with a 10-inch furrow. Long manure is also, when applied, ploughed in with as little difficulty. The land in spring is ridged with horses; dung is applied, the ridge is split by horse-plough, and left for deposit of seed. For wheat after potatoes, only one scarifying is required; for oats, the land is skimmed before winter, and a 6-inch furrow, with 10 loads of manure, is given before sowing; for green-rye, the land is scarified, dunged, and ploughed in September, and sown directly, so that it may be cleared from May to July following. As the green-rye is cut, the land is dunged and ploughed (generally by horse-power), and so long as the season serves, it is replaced by cabbages, dibbled, followed by turnips, rape, &c. Should the cabbages be removed in March, the land by a single furrow is fitted for spring-wheat; if in April, for barley. For wheat, after seeds, one furrow suffices. It will be readily perceived that this quick rotation and constant occupation of the land necessitates a vast amount of labour, and of labour which must be done, if it is to be profitable, just at the nick of time. The tendency of such land so occupied is to become weedy; the success of such culture depends on cleanli-

ness, and the value, therefore, of machinery that can quickly be applied to the cleansing of a large area between crops must be apparent. Under such circumstances, the application might be profitable, even though in expensiveness it exceeded the application of horse-power. Below is a summary of the work done:—

For the crop of 1861	—Land under tillage		400 acres
	Days at work ploughing and scarifying ..		70 days
	(or 5¾ acres per day).		
1862	—Land under tillage		510 acres.
	Days at work ploughing and scarifying	115	
	Ploughing for hire	45	
	(or 4½ acres per day)	—	160 days.
1863	—Land under tillage		510 acres.
	Days at work ploughing (6 acres per day)	84	
	Days at work thrashing	21	
		—	105 days.
1864	—Land under tillage		510 acres.
	Days at work ploughing (6¾ acres per day)	75	
	Days at work thrashing	26	
		—	101 days.
1865	—Land under tillage		510 acres.
	Days at work ploughing (9½ acres per day)	54	
	Days at work thrashing	29	
		—	83 days.

The reader will observe in scanning these figures that, as the days occupied in thrashing increase, those occupied in ploughing decrease. This circumstance indicates, in the first place, that a larger bulk of grain has to be dealt with; in the second, that there is increased facility in working. It may be well to remark that the number of days' work done by the tackle in 1860 would have been greater but for the wet autumn; and that in 1863, and again in 1864, the entire crop was thrashed by the ploughing-engine, the produce in each year of 575 acres being thus dealt with. At no time during this period did the number of horses exceed 9, except occasionally in harvest.

Cost of Work.

	£.	s.	d.
Manual Work:—			
Engine-man	0	3	10
Ploughman	0	2	6
Anchor-man	0	1	6
2 porter-boys	0	1	10
1 boy, horse, water-cart	0	6	4
	0	16	0
Coals	0	9	11
Oil	0	1	0
Total expenses per day	1	6	11

N.B.—All work done by the day. Piecework is "scamped," and therefore

avoided. *Coals*—"Lascoe," 18*s.* 6*d.* per ton home, consumption about 12 cwt. per day.

Mr. Arnot has run out the expenses of working for three years, from 1st September, 1862, to 1st September, 1865, on the farm, and presented the result in the following Table, which is worthy of consideration :—

Number of Days.	Work done.	Expenses.	£.	s.	d.
	Acres.				
Ploughing and scarifying 213	Ploughing and scarifying 1510	Wages: ploughing . .	157	8	6
Thrashing 74	Thrashing 920	„ thrashing . .	114	14	8
		Coals	137	14	5
		Engineering and tradesmen's accounts . . .	45	8	2
		Oil, grease and coals . .	22	7	0
		Shares and renewals . .	49	0	0
			526	12	9

If expenses pertaining to thrashing are separated from this account, the sum left to be divided amongst the 213 days will be 384*l.* 14*s.* 6*d.*, or 1*l.* 16*s.* 1¼*d.* per day; the difference, 9*s.* 3*d.*, having to meet the expenses (not included in the daily expenses above) for repairs, &c. &c.

But there is another aspect of this subject. Nine horses have been dispensed with :—

	£.	s.	d.
The cost for 9 horses may be fairly assumed to be, including attendance of men, harness, implements	183	0	0
Hay	108	0	0
12 acres green meat	84	0	0
Depreciation and interest on 9 horses valued at 40*l.*	45	0	0
	420	0	0

Adopting the above calculations, and comparing the total cost of the steam-tackle which replaces, and much more than replaces, these 9 horses, it will be found that the gain is 177*l.* 14*s.* 2*d.* per annum by the use of steam. Thus,

	£.	s.	d.
The annual expense of 9 horses	420	0	0
The annual expense of steam tackle	242	5	10
	177	14	2

Many readers will very justly object that their horses do not undergo depreciation while in their keeping; but that they improve, and are a yearly source of profit, and that allowance should be made for their manure. These objections must, of course, be allowed when they are well founded; no attempt has been made to balance the two accounts exactly. Having the facts before him, the reader may do this for himself.

With reference to the increase in the crops, it is only fair to

state that Mr. Arnot, who keeps little or no stock, contracts very largely for London manure, and applies it with a liberal hand. Our opportunities for seeing the farm, owing to heavy rain, were very limited. What we did see attested the enterprise of the tenant, but showed that the season had seriously interfered with the cleansing of land. Mr. Arnot considers that, on light land, 10 per cent. on the outlay is sufficient to cover the wear and tear, and maintenance of the whole apparatus.

No. 30. Mr. Cooper, of Fen Drayton, near St. Ives, welcomed us on the 18th of September, and soon made us feel that he was quite at home with his work. Some years ago he removed to Fen Drayton from Sandy, in Bedfordshire, where he had been accustomed to market-garden culture. He commenced the growth of onions, cucumbers, gherkins, potatoes, for the great vegetable markets, and soon aroused a healthy spirit of emulation in the district; so that he not alone benefited himself, but the neighbourhood generally—particularly the labourers, who are thrifty and well to do. How far they owe their condition to his enterprise may be gathered from the fact, that his yearly expenditure for labour amounts to 2000*l.* He did not set the fashion in the employment of steam, but followed the lead quickly, and so successfully as to induce many to do likewise. He swears by Fowler; and it is a noticeable fact, that there are now no less than four double sets and seven single sets of tackle by the same maker at work in this immediate neighbourhood, besides as many more from the Bedford works, and from Woolston, of which he said nothing.

Mr. Cooper farms 500 acres of land—300 acres, lying in the parish of Fen Drayton, are his own by recent purchase; 200 acres of hired land lie away at Hilton, a village 3 miles distant. Saving 30 acres, the whole is arable. For the most part it is light, needs no artificial drainage, can be ploughed with two horses, and produces large crops of vegetables and grain. The farm lies in large fields, divided by straight, well-kept fences, destitute of timber; it is also well supplied with water of good quality; and is managed on the four-course, except when the market-garden system is followed.*

The work of the farms is done by nine horses and two sets of steam-tackle. But the tackle do all the thrashing, grinding, and a great deal of contract-work, on which they are principally employed; the nine horses are more used on the road, carrying produce and manure to and from the railway station, than in

* The second (double) set was only bought in March last, and therefore had no share in the work, and is not chargeable with expenses. Its purchase is noticed for the purpose of stating the advantages Mr. Cooper expects to derive from its use.

tillage operations. The same number of horses used to be kept when the farm comprised only 120 acres. Without steam-power fully eight additional horses would be required. There is no little difficulty, however, in ascertaining what amount of power is thus placed at the disposal of, and should be charged to, the farm. Mr. Cooper has kindly supplied us with a tabular statement, in which it will be found that the engine's work has been charged so many days against the farm on the same scale as that charged to customers. This of course shows a considerable margin for profit, which throws up the expense per acre much above what it would be were a cost-price scale adopted. Mr. Cooper stated that his customers testify to the results of steam cultivation in the production of larger crops, and crops of better quality. Light land, in his opinion, burns less, and heavy land suffers less from wet. It is a prevalent opinion that steam will do away with covenants and bare fallows, and render leases more than ever indispensable.

As in Mr. Arnot's case, the value of despatch, where one crop quickly succeeds another, is self-evident. The *home*-farm, over which we walked, gave evidences of careful and successful cultivation. Where so many hands are at work, it is essential to quicken the pace. The men step out, so that the "agricultural pace," which has become a proverb, is nowhere here to be seen. They work by the piece, and are effectually supervised.

The Apparatuses.—The first purchase made of Messrs. Fowler, in 1862, consists of 1 engine, 14-horse power, double cylinder, traction; 1 4-furrow plough; 1 cultivator, 800 yards ropes, anchor, and porters: price 945*l.*

The second, bought March, 1866, consists of two 10-horse-power engines with winding-drums, single cylinder, 4-furrow plough, 1 cultivator, 800 yards of rope and rope-porters: price, 1300*l.*

The daily expense of using this second set, according to Mr. Cooper's experience, is as follows:—

	£.	s.	d.
Manual-labour:—			
2 engine-men	0	6	8
1 ploughman	0	2	6
1 water-cart man	0	2	0
2 boys	0	2	4
Horse	0	5	0
	0	18	6
Coal	0	15	6
Oil	0	1	6
Total cost of day's work	1	15	6

N.B.—The 3 men have 4*d.* per acre, and the 3 boys have 2*d.* per acre for

ploughing and digging once, and for cultivating twice over. They work from light till dark. The *Coal* is "Seeleys," 15*s.* 6*d.* per ton, home: consumption, 1 ton per day. The repairs on this set have not been ascertained.

It is Mr. Cooper's impression that the two engines consume no more coal or water than the single engine. This tackle is set down in 10 or 12 minutes. It will do 2 or 3 acres a-day more than the single set. These advantages distinguish it as specially applicable for the purpose he has in view, namely, to keep it working on contract jobs. Some little difficulty is felt in supplying the engine on the upper headland with water when the land under cultivation is in tilth: in case of stubble and firm ground, the slack-rope pulls the water-cart from the bottom to the top end. When, in travelling, a miry place or a hill is met with, one engine helps the other. The machinery is very simple, and occasions no fear of breakages. As the engine-men, who were farm-labourers, are much left to themselves, they are inspired with a lively interest in their work: in other words, they are well paid. Mr. Cooper provides in every way for their comfort. We found him building an engineer's-house on four wheels, with interior dimensions 14 feet by 7, to hold 3 beds; fitted with cooking-stove, and capable of accommodating three men and two boys. It is constructed with two windows, a door, and movable ladder behind. The fabric is of wood, shielded by corrugated iron, and is yet so light that two horses or the engine can pull it. This arrangement, in districts scantily populated, is evidently necessary where contract-work is taken. Mr. Cooper spoke very strongly about the superiority of the double set of tackle over the single. "If," said he, "the question is to get over a certain quantity of work in a given time, that implement which will do it best is the best to buy." So convinced is he of this, that he will either part with the single set he now has, or buy another 14-horse power engine to complete it. The obstacle to its general use is the price. He considered that a man with 400 acres of arable land would do well to buy a double set of tackle; but he would dissuade any man from doing so unless he takes a personal interest in steam. Abundance of work may be found for the engines by contracting to thrash, cut chaff with Maynard's apparatus, or grind with the American grist-mill, both which machines he uses.

Repairs, Renewals, Wear and Tear.—Particulars to come under this head may be gathered from Mr. Cooper's tabular statement. Respecting the *rope*, however, it will be well to remark that 500 yards were bought in 1864, and 500 in 1866. The tackle was not at hand for inspection.

Work done with single engine tackle, and Mode of doing it, per

day of 10 hours, including removals. In preparing for roots, the stubble is broken up 6 inches deep, manured in the frost (January), and cross-ploughed in spring 6 or 7 inches. For further particulars, see Statement.

Cost of Work with Single Engine Tackle.

	£.	s.	d.
Engineer, 3s. 4d.; ploughman, 2s. 6d.; anchorman, 2s.; water-cart, boy and horse, 5s.; 3 rope porter-boys, 3s. 8d.	0	16	6
Coal, 1 ton	0	15	6
Oil	0	1	6
	1	13	6

The 3 men have 4d. an acre extra divided amongst them for once ploughing and twice cultivating. The 4 boys have 2d. an acre extra for once ploughing and twice cultivating.

The piece-work money, supposing the average day's work was 6 acres, would be 3s., which, if added to 1l. 13s. 6d., will increase it to 1l. 16s. 6d. This, then, will represent the expense of a day's work, without any charge for interest and maintenance, for which Mr. Cooper allows 20 per cent. upon the cost of the tackle.

Wear and Tear from July 20 to Nov. 18.

	£.	s.	d.
8 dozen shares, 11s.	4	8	0
21 clips, 1s.	1	1	0
2 pulleys, 2s.	0	4	0
1 digging-breast	0	3	6
2 small rope-porters, 20s.	2	0	0
5 rope eyes, 2s. 6d.	0	12	6
6 rope-porter wheels, 3s. 6d.	1	1	0
1 new road clutch, 25s.	1	5	0
Repairing spindle in plough	0	6	0
Sharpening coulters (four times)	1	12	0
Incidental expenses	5	0	0
28 shiftings, with two horses, 5s.	7	0	0
	24	13	0

These repairs, effected during a period of 17 weeks, give 29s. 11½d. a week.

Mr. Cooper's elaborate statement of the work done, and the cost of doing it, which here follows, will command attention. Such details are much too scarce. In the first place we are directed to the year 1862. There we find the description of work, the nature of the soil on which it is done, the time occupied in doing it, and the worth of the work. The cost of the tackle, added to the expenses of working, are balanced at the end of each year, and the balance is carried forward. Thus, 631l. 18s. 10d. is carried forward to the year 1863, and 261l. 4s. 6d. to the year

1864. The account stops Nov. 14, 1864; but it will be seen then that the balance to be carried to the account of 1865 would be 96*l.* 2*s.*

Date.		Description.	Acres.	Soil.	Depth.	Cost.			Value of Work.		
					Inches.	£.	s.	d.	£.	s.	d.
1862.		Cost of Tackle ..	..	..	..	945	0	0			
July	29	Digging*	15	Stiff Clay	7	..			18	0	0
,,	31	Ditto	25	Loam ..	8	..			25	0	0
Aug.	5	Cultivating	44	Clay ..	6	..			22	0	0
,,	11	Digging	16	Gravel ..	8	..			16	0	0
,,	13	Ditto	12	Ditto ..	8	..			12	0	0
,,	20	Ditto*	24	Ditto ..	8	..			20	0	0
,,	23	Ditto	12	Ditto ..	8	..			12	0	0
,,	26	Ditto	30	Ditto ..	9	..			30	0	0
,,	29	Ditto	12	Stiff Clay	8	..			16	5	0
Sept.	4	Cultivating	48	Stiff ..	8	..			24	0	0
,,	10	Digging	15	Stiff Clay	8	..			15	0	0
,,	14	Cultivating	24	Loam ..	7	..			12	0	0
,,	17	Digging	43	Ditto ..	9	..			43	0	0
,,	25	Ditto*	22	Stiff Loam	7	..			22	0	0
,,	25	Ditto*	12	Meadow	7	..			11	0	0
Oct.	4	Ditto*	29	Stiff Clay	6	..			36	5	0
,,	17	Ditto*	17	Ditto ..	6	..			20	0	0
,,	23	Ploughing	60	Gravel ..	10	..			52	10	0
Nov.	5	Digging*	20	Stiff.. ..	10	..			20	0	0
,,	11	Ploughing	15	Gravel ..	8	..			9	7	6
,,	14	Ditto	15	Stiff.. ..	10	..			15	0	0
,,	26	Ditto	30	Gravel ..	9	..			22	10	0
Dec.	4	Ditto	26	Ditto ..	9	..			19	0	0
,,	28	Ditto	12	Ditto ..	9	..			9	0	0
		Horse water-cart ..	..	..	..	19	4	0			
		Oil	..	..	..	7	0	0			
		24 shiftings, at 5*s*...	..	..	..	6	0	0			
		79 tons coal, at 14*s*.	..	..	..	55	6	0			
		Carting coal, at 2*s*. per ton	..	..	..	7	18	0			
		Wearing parts and breakages	..	..	..	17	11	0			
		Incidental expenses	..	..	..	5	0	0			
		Blacksmith's Bill ..	..	..	..	8	5	4			
		For labour	..	..	..	62	12	0			
			577	..	..	1133	16	4	501	17	6
		Deduct value of work	..	..		501	17	6			
		Balance carried forward	..	..	..	631	18	10			

N.B.—Odd measure is not put into this account, and the engine not credited for thrashing, chaff-cutting, and grinding.

* Work done for hire.

Date.	Description.	Acres.	Soil.	Depth.	Cost.			Value of Work.		
				Inches.	£.	*s.*	*d.*	£.	*s.*	*d.*
	Balance brought forward	..	..	..	631	18	10			
1863.										
Feb. 2	Ploughing	9	Loam ..	9		..		9	0	0
,, 11	Ditto*	6	Grass-land	5		..		7	10	0
,, 13	Cultivating	44	Gravel ..	10		..		22	0	0
,, 24	Ploughing	30	Ditto ..	10		..		22	10	0
Mar. 2	Cultivating	26	Stiff Clay	6		..		13	0	0
,, 5	Ploughing	13	Ditto ..	6		..		9	15	0
,, 7	Cultivating	24	Loam ..	10		..		7	4	0
,, 12	Ploughing	30	Stiff	9		..		22	10	0
,, 24	Cultivating	9	Meadow	10		..		2	5	0
Apr. 18	Digging*	30	Stiff Clay	6		..		20	0	0
May 1	Ditto*	19	Ditto ..	6		..		15	0	0
,, 8	Ditto*	26	Ditto ..	6		..		18	15	0
,, 23	Ditto*	6	Ditto ..	6		..		6	0	0
June 4	Digging*	14	Ditto ..	6		..		14	0	0
,, 24	Ditto*	13	Ditto ..	7		..		13	0	0
July 14	Cultivating*	32	Ditto ..	7		..		18	16	9
,, 24	Ditto	60	Gravel ..	6		..		22	10	0
,, 29	Ditto*	34	Stiff ..	6		..		20	10	0
Aug. 4	Ditto	30	Meadow	6		..		15	0	0
,, 10	Ditto	60	Medium	6		..		30	0	0
,, 17	Ditto	50	Stiff ..	7		..		31	0	0
,, 22	Ditto	32	Clay ..	7		..		22	0	0
,, 29	Ditto	60	Gravel ..	10		..		30	0	0
Sept. 3	Digging	10	Ditto ..	9		..		10	0	0
,, 5	Cultivating	24	Stiff Clay	8		..		15	0	0
,, 10	Digging	12	Gravel ..	9		..		12	0	0
,, 12	Cultivating and Harrowing	10	Ditto ..	9		..		5	0	0
,, 14	Digging*	15	Ditto ..	7		..		11	5	0
,, 17	Cultivating and Harrowing	20	Ditto ..	9		..		10	0	0
,, 21	Ditto	70	Medium	7		..		35	0	0
,, 30	Ploughing and Cultivating*	6	Light ..	8		..		6	0	0
Oct. 8	Cultivating	27	Stiff ..	7		..		12	0	0
,, 17	Ploughing	31	Stiff Clay	7		..		23	5	0
,, 24	Ditto	20	Gravel ..	7		..		12	0	0
,, 28	Ditto	30	Ditto ..	8		..		18	0	0
Nov. 3	Ditto	30	Ditto ..	7		..		22	10	0
,, 11	Ditto	8	Ditto ..	6		..		6	0	0
,, 13	Ditto	37	Ditto ..	6		..		27	15	0
,, 23	Cultivating and Ploughing	17	Stiff	8		..		8	10	0
Dec. 17	Ploughing	30	Sand ..	10		..		22	10	0
,, 22	Ditto	15	Stiff	7		..		15	0	0
,, 26	Ditto*	10	Light ..	10		..		5	0	0
,, 28	Ditto*	12	Ditto ..	10		..		7	4	0
,, 31	Ditto	8	Clay ..	7		..		6	0	0
	Carried over	1099	..	..	631	18	10	681	14	9

N.B.—Odd measure not put in this account. Engine not credited for thrashing, chaff cutting, and grinding.

* Work done for hire.

Date.	Description.	Acres.	Soil.	Depth.	Cost.			Value of Work.		
				Inches.	£.	s.	d.	£.	s.	d.
1863—*continued.*	Brought forward ..	1099	..	..	631	18	10	681	14	9
	96 tons coal, at 14s.	..	..	..	67	4	0			
	Horse water-cart ..	..	..	..	33	16	0			
	Labour	..	..	..	90	12	0			
	Shifting 46 times, at 5s.	..	..	..	11	10	0			
	Wearing parts and breakages	..	..	..	17	11	0			
	Smith's Bill	..	..	..	10	0	0			
	Extra expenses ..	..	..	..	6	0	0			
	Oil	..	..	..	11	4	8			
	Int. on 631*l.* 18*s.* 10*d.*, at 10 per cent. ..	..	..	..	63	2	9			
		1099	..	..	942	19	3	681	14	9
	Deduct value of work	..	..	..	681	14	9			
	Balance carried forward	..	..	..	261	4	6			
1864.										
Jan. 2	Cultivating	8	Light ..	8		..		4	0	0
,, 25	Ploughing	12	Stiff Clay	6		..		12	0	0
Mar. 2	Ditto	20	Gravel ..	8		..		12	0	0
June 12	Digging*	17	Stiff	8		..		17	0	0
,, 27	Ploughing*	7	Ditto ..	8		..		4	14	6
July 2	Cultivating	60	Ditto ..	7		..		72	9	2
,, 12	Ditto*	44	Ditto ..	8						
,, 23	Ditto*	60	Ditto ..	6		..		30	8	4
Aug. 8	Ditto	60	Gravel ..	6		..		30	0	0
,, 12	Ditto	16	Ditto ..	7		..		8	0	0
,, 15	Ditto	24	Stiff Clay	7		..		12	0	0
,, 18	Ditto	18	Stiff Loam	9		..		9	0	0
,, 19	Ditto	16	Stiff Clay	7		..		8	0	0
,, 22	Ditto	62	Ditto ..	6		..		30	0	0
Sept. 2	Ditto	76	Stiff Loam	8		..		38	0	0
,, 15	Ditto	30	Stiff	6		..		15	0	0
,, 22	Digging	20	Ditto ..	8		..		20	0	0
,, 28	Ditto	10	Ditto ..	7		..		10	0	0
,, 30	Ditto	30	Gravel ..	7		..		22	10	0
Oct. 5	Ditto	15	Stiff Loam	8		..		15	0	0
,, 8	Ploughing	32	Gravel ..	7		..		24	0	0
,, 14	Cultivating and Harrowing	30	Loam ..	8		..		15	0	0
,, 17	Ditto	20	Stiff Clay	7		..		7	10	0
,, 22	Ploughing	13	Loam ..	6		..		6	10	0
Nov. 2	Ditto	10	Stiff Clay	6		..		9	0	0
,, 4	Ditto	30	Ditto ..	6		..		27	0	0
,, 10	Ditto	8	Ditto ..	6		..		6	0	0
,, 11	Ditto	10	Ditto ..	10		..		7	10	0
,, 14	Cultivating*	50	Stiff Loam	7		..		25	0	0
	Carried over	808	..	..	261	4	6	497	12	0

N.B.—Odd measure not put in this account. Engine not credited for thrashing, chaff-cutting, and grinding.

* Work done for hire.

Date.	Description.	Acres.	Soil.	Depth.	Cost.	Value of Work.
1864—*continued.*				Inches.	£. s. d.	£. s. d.
	Brought forward ..	808	..	..	261 4 6	497 12 0
	Wearing parts and breakages	..	..	..	57 11 9	
	Labour	..	..	..	82 19 0	
	Shifting 33 times, at 5*s.*	..	..	..	8 5 0	
	Smith's Bill	..	..	..	10 0 0	
	Incidental expenses	..	..	..	6 5 0	
	Oil	..	..	..	9 2 6	
	60 tons coal and carting, at 17*s.*	..	..	..	51 0 0	
	Horse-water-cart ..	..	..	..	25 4 0	
	500 yards steel rope	..	..	..	56 0 0	
	Int. on 261*l.* 4*s.* 6*d.*, at 10 per cent. ..	..	..	..	26 2 3	
		808	..	..	593 14 0	497 12 0
	Deduct value of work	..	..	..	497 12 0	
	Balance carried forward	..	..	..	96 2 0	

N.B.—Odd measure not put in this account. Engine not credited for thrashing, chaff-cutting, and grinding.

The summary of the account for the three years is as follows:—

	Acres Worked.	Expenses. £. s. d.	Receipts. £. s. d.
1862	577	188 16 4	501 17 6
1863	1099	311 0 5	681 14 0
1864	808	332 9 6	497 12 0
	2484	832 6 3	1681 3 6

No interest will be found charged against the outlay in 1862, because the apparatus was paid for by bills of long date.

The work distinguished thus (*) was done for hire, Mr. Cooper finding neither coal, horse-labour, nor water. For work done at home, of course he has to find both. Yet with this difference he charges himself the same sum per acre as he does his customers.

No. 31. Mr. W. L. Woods, of Chilgrove, near Chichester, and his father before him, have clothed an unattractive elevation with beauty. In the winter-season the climate is sufficiently severe to warrant the name. The house stands at an elevation of 280 ft. above the sea-level, and some parts of the farm are much higher. The farm is his own; it consists of 345 acres of arable land and 50 of pasture. It may all be ploughed with 2 horses; the subsoil is chalk. In some parts the staple is a stiffish red soil, in

others a thin chalky soil, 5 inches deep, is found not good for turnips, but productive of wheat and oats. There are 2 courses of cropping:—1st, the common 4-course crop; 2ndly, 2 crops of swedes, turnips or rape; wheat; seeds; oats; or two years turnips, oats, seeds, and wheat. These variations are tried to adapt the cropping to the season. In such a situation wheat must be sown early. The fields vary from 15 to 17 acres. The storage of water, at such altitude, requires great attention, since the natural supply fails when it is most needed. Mr. Woods has spouted all his buildings, cottages, &c., and preserves in large tanks the greater part of the abundant rainfall of that neighbourhood. His arrangements, in this respect, have been very successful. The power at his disposal consists of 12 horses (4 bullocks were sold when the tackle was bought) and Smith's apparatus, bought in 1861. It consists of an

	Price. £.
Engine of 8-horse power, with single cylinder and portable, made by Butlin, the hind carriage being fitted with springs, which greatly reduce the jar in travelling	230
Cultivators, 1400 yards *rope*, *windlass*, *porters*, &c...	250
	480

The *engine*, which never quits the farm, is used about 36 days in a year to thrash, grind (when it works in a capital house), and about 10 days in the field, when it is worked up to 70 lbs. steam pressure. The apparatus has been well taken care of, and has cost little or nothing for repairs. The expenses on the engine cannot be put down at 5*l.* per annum.

Work done.—The stubbles are not broken up till late; they are then ploughed with horses. Steam is used in spring only to fallow for turnips, while the horses are engaged preparing for oats and spring-corn, during 10 days, in March and April. Removals included, which occupy 6 horses and 2 men a ½ day, the pace per day is 8 acres with the 5-tine cultivator:—

Wear and tear is estimated by Mr. Woods at 10*s.* per day.

We thus estimate the entire cost in this case:—

	Per day. £.	*s.*	*d.*
The manual labour amounting to 19*s.*, and the coal and oil to 10*s.*, make the total day's expense	1	9	0
5 per cent. interest on 350*l.* (100*l.* on engine) divided amongst 10 days..	1	15	0
Maintenance, 5 per cent. on 350*l.*, the work being light, divided amongst 10 days..	1	15	0
	4	19	0

This gives 49*l.* 10*s.* for 10 days' work. Many would be disposed to grumble at this result, and certainly the employment of steam

in this case reminds one of calling forth the ponderous energy of the steam-hammer to crack a nut; but still Mr. Woods is satisfied. If by laying out 50*l.* he is able to secure 100*l.*, he is clearly in the right. Without steam in those 10 days, it appears that no other power he could avail himself of would enable him to follow out the course of cropping decided to be best adapted to the situation. He gains a crop, and looks to this gain for reimbursement.

The average wage for day-labour is 2*s.* per day.

The engine burns Newcastle coal, 27*s.* per ton at home. Consumption from 5 to 7 cwts. per 10 hours.

No. 32. Mr. J. Lancashire, Micheldever, Hampshire. Catching an early train from Southampton on the morning of the 27th of September, we arrived to breakfast, and subsequently made a tour of the farm and saw Howard's apparatus doing some very good work. The farm contains 725 acres lying on the chalk over an undulating surface. On the uplands the depth of soil is about 3 inches, in the lowlands 3 feet. When Mr. Lancashire entered, five years since, it was exhausted of fertility and possessed by weeds. The change wrought is due to the spirited investment of capital, in which steam has its share. Labour, for instance, costs 1*l.* per acre, while the annual outlay in artificial manure, cake, and corn may be put down at a little over three rents. For bones and phosphates alone the expenditure is 500*l.* The owner, Lord Northbrook, allowed his tenant to enlarge fields which now average 30 acres; the hedgerows are low and denuded of timber. Something has been done to construct roads. The supply of water is scanty; and, coming from the chalk, is so bad in quality that a wine-glassful of Le Franc's fluid is used each morning, which costs 1½*d.*, and serves the day. The effect is surprising; were it not for this remedy the wear in the boiler would entail heavy expense. The course of cropping is as follows: (1) roots, (2) wheat or barley, (3) seeds, (4) wheat. On wheat-stubble tares or trifolium are taken before roots, two crops in one year—a great point, much facilitated by the use of steam. On the inferior land he secures two root-crops, and takes wheat or oats seeded down. The seeds lie two years, and are then broken up for wheat or oats. Mr. Lancashire's great object is to get sheep-feed. A flock of 600 breeding ewes (with the female produce) gives an average of 800 mouths to be filled from the 725 acres, besides other stock. He farms also very much for the great Hay-market which he supplies with large quantities of sainfoin hay.

For labour he is inconveniently situated. Mitcheldever is two miles distant. He has but eight cottages; three of which, brick upon good foundations, have been erected at his own expense.

The wages for ordinary labourers, 10*s.* a week, are high, considering their indifferent character. The hours of labour, from 6 A.M. till 5·30. The employment of steam gives him advantages, for the best class of men crave the better wages connected with its use, and are stimulated to better pace. Mr. Lancashire very sensibly trains the men to the use of the engine; he explains to them sectional drawings of the machinery, thoroughly indoctrinates them into its principles, ensuring at the same time that they possess a competent knowledge of the combustion of fuel and the production and expansion of steam.

Mr. Lancashire's experience indicates that the employment of steam tends to lengthen the labour-list. This ought not to surprise us if we bear in mind that the engine only "cuts out the work" of more thorough and frequent tillage, leaving the finishing touches to be done by the hands. Since these run short, he is obliged, like the American farmer, to resort to various implements. He owns 2 large corn-mowing and 3 grass-mowing machines. With the former, supported by 8 scythes, day by day he swept down 46 acres of corn, and was placed very advantageously in advance of several neighbours, who were caught by the heavy rains. To keep these machines thoroughly employed in their several seasons, 12 horses are needed. The entire stud consists of 14, that is 2 to each 100 acres. To have produced part only of the change he has done, "would," to use his own words, "have required 20 horses."

The *Apparatus* was bought of Messrs. J. and F. Howard in 1861.

The *Engine*, an 8-horse power double cylinder, was made by Messrs. Tuxford, and having been worked six years was purchased for 130*l.* The new engine works up to 100 lbs. steam-pressure with as much safety as some engines with 45 lbs. This is due to extra stays, the advantages of which are not sufficiently known. A thick boiler-plate, unstayed, is of little advantage. If guaranteed to work to 100 lbs., an engine stands much longer than one of inferior strength.

The *Cultivator*, windlass, 1400 yards of rope, porters, from Bedford, cost 240*l.*

Repair, Renewals, Wear and Tear.—The *engine*: during the four first years repairs did not reach 5*l.*; those incurred were due to frost. The slightness of the expense is attributed to the use of the fluid already mentioned. The repairs in 1865 were 5*l.* A stronger engine being required, the one of 8-horse power was valued at 130*l.*, returned to the makers, who, on receipt of 170*l.* in addition, sent a 10-horse power engine extra stayed. "The engine does not cost 9*s.* a day to keep in repair and renew in 8 years. If I lay by 7*s.* a day, Mr. Tuxford would be willing to renew it for the sum of the deposits so made, whenever it shall

be worn out." The former engine has been used for thrashing, grinding, chaff-cutting, about 2 days each week for 30 weeks.

The rope was supplied in additional quantities last autumn, and the present—1865, 1866—the price of which, diffused over the acres cultivated, shows the wear then to be just 1*s.* 3*d.* per acre.

Work done and Mode of doing it.—The day's work of 10 hours, including removals:—First time, breaking up 6 inches deep, average 5 acres; second time, 6 or 7 acres. It is customary to break up the stubbles in harvest, manure, and sow tares to be early fed, and then broken up for turnips:—

Cost of Work.

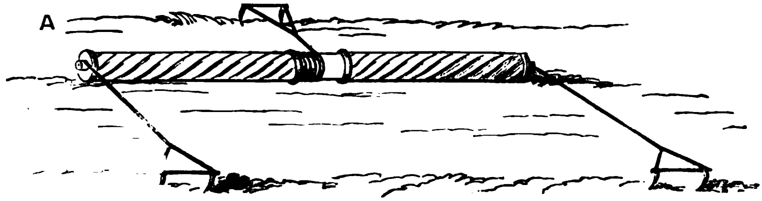
	£.	s.	d.
Manual Labour:—			
Engineer	0	2	6
Windlass-man	0	2	0
2 anchor-men	0	3	8
Ploughman	0	1	8
2 porter lads	0	1	8
Boy, water-cart, horse	0	5	6
	0	17	0
Coal and oil	0	7	3
Total daily expense	1	4	3

N.B.—The men receive 2*d.* per day extra, and occasionally a quart of ale. "Ale goes further than money." *Coal*—"Shipley Hards," from Derbyshire. 18*s.* per ton home, consumption 7 cwt.

The choice between a long rope and infrequent shiftings and a shorter rope and more frequent shiftings depends, in Mr. Lancashire's opinion, on the nature of the soil. If a sharp soil, very little rope should be out; some advocate 2000 yards of rope—he does not.

The old rope is used between the anchors on the headlands, with a sling (Fig. A). He has often seen old ropes coiled up doing nothing; sometimes served out to act as the top-wire of fencing. He considers 500 acres of arable land the smallest quantity on which steam cultivation should be practised; would advise no one to go into it without intending to pay thorough personal attention to the machinery. If left to men, it will be sure to be a failure.

A



[illegible] man is a raw recruit. There is a smith's shop on

the premises, but no engine-shed; the rope is dressed with tar and grease before being put away.

No. 33. Mr. Redman, Abbotstone, Alresford, Hampshire, September 28th. This gentleman is known to have used Fowler's tackle for several years upon extremely heavy land near Swindon, in Wilts. Within the last two years he removed to the above farm. where he occupies 1100 acres upon the estate of Lord Ashburton, He has taken his steam tackle with him, which may be regarded as an indication that he values it and cannot part with it. He speaks strongly of the improvement effected in the drainage of the strong land lately relinquished, by deepened tillage; but declined to admit any increase in yield. The main advantage, he says, consists in the expeditious manner in which the fallows are cleaned, which facilitates the sowing of a large breadth of corn. Of the whole area of his present occupation 750 acres are arable, 50 are water-meadow, 50 dry-meadow, and 250 down-land. The staple is thin—of a red calcareous nature—upon chalk subsoil; it needs no drainage, and is well supplied with water from the river Itchen. Two horses make easy work of a furrow 4 or 5 inches deep. The 4-course system of cropping prevails throughout the neighbourhood. Mr. Redman is proposing to change it to the following: 1, roots (swedes); 2, roots (rape or turnips); 3, wheat; 4, barley; 5, seeds; 6, oats. The horses kept are 15—2 to 100 arable acres. Without steam he must have had 20. Although possessed of steam, he is convinced that there exists no power so cheap on light land as a pair of horses; but horses fail where expedition is wanted. The landlord has let the adjoining mansion and park to a sportsman. The game harboured in the neighbouring preserves must prove a serious hindrance to anything like successful farming.

The *Engine* was of 12-horse power, double-cylinder, traction. The *Apparatus* was bought in 1858, when Mr. Redman was farming 450 acres of very strong land. An agreement being made with Mr. Fowler, who was a great friend and a native of the same place, that, as improvements were made, he should have them, these improvements are now embodied in the present tackle. Mr. Redman uses his own *cultivator*, which he considers superior to any yet brought out. We were prevented from seeing either it or the tackle, from their being at work some miles away.

Repairs, Renewals, Wear and Tear.—The repairs of the engine cost about 40*l.* per annum, 30*l.* of which should be charged to steam-cultivation. The wear and tear on other parts of the apparatus is slight, except the rope, the shares, and the points, when the ground is much baked.

Work done and Mode of doing it.—During a day of 10 hours, removals included, the 4-furrow plough works from 5 to 8 acres 3 to 6 inches deep; the cultivator 10 acres, 4 to 8 inches deep. He seldom uses the plough on his own land. From July, 1865, to the end of the year, he scarified at home 290 acres; from January, 1866, to the day we arrived, he had scarified 319 acres and ploughed 50. About the same work has been done each year abroad for hire. To prepare 85 acres for roots this year he has broken up and crossed the stubbles from 6 to 7 inches deep, with a drag-harrow attached to the cultivator; these are now perfectly clean. He will plough in winter by horse-power, and then putting steam again to work to draw the cultivator through the pulverised soil, will drill with artificial manure.

Cost of Work.

	£.	s.	d.
Manual Work:—			
Engine-man	0	3	6
Ploughman	0	3	0
2 porter-boys	0	2	6
1 anchor-man	0	2	0
Boy, cart and horse	0	4	6
	0	15	6
Coals	0	12	0
Oil and grease	0	1	6
Total cost per day	1	9	0

N.B.—No extra payment to men, except for overtime. The ordinary daily wage for labourers in the neighbourhood is 1*s.* 8*d.* When not steaming the engine-man is paid 15*s.* a week. The "hard" coal is used; the cost per ton home is 22*s.*; the consumption per day about 9 cwts.

Mr. Redman considers a rope of 450 yards the proper length to be used with advantage to his own tackle. This (costing 45*l.*) should cultivate 1500 acres, which would bring the expense to 7½*d.* per acre. He thinks, also, that 15 per cent. upon outlay will cover all contingencies, interest of outlay, and supply a new apparatus when required. In his opinion the occupation of a farm of 400 acres of heavy land would justify a man in the purchase of steam tackle as a profitable investment. He experiences no difficulty from flints on light soil except when the ground is very much baked. We did not consider it necessary to make a close inspection of a farm so recently brought under steam cultivation.

Our tour comprised two or three other farms which did not present any features of special interest.

CONCLUSION.

Having thus afforded a somewhat minute sketch of our tour of inspection, we proceed to the statement of some general impressions or conclusions that seem to arise naturally from it.

The main objects of the inquiry were twofold: first, to ascertain the actual results of the application of steam-power to tillage operations; second, to discover the hindrances that check its further progress.

Upon the medium and the heavy soils the benefits obtained are undeniable. A culture deeper than it is possible for horses to effect works a highly beneficial change in the texture of the soil, imparts additional efficiency to drainage works, augments the value of the manure applied, brings into operation certain latent properties of the soil, which much increases its fertility; it also fits land, formerly unfit, for the growth of turnips, allows of their being fed off by sheep, the operations of the field are economised, and the growth of all crops is stimulated. In nearly all the cases reported it will be seen that the expenses of cultivation are very much reduced, and yet that a larger amount of produce is said to have been realised. The reduction of expenditure is more susceptible of proof than increase of produce. As to the first, we had definite statements made to us; as to the last we can only report general impressions. There can, however, be no manner of doubt that a large increase is obtained where the bare fallow is abandoned, and a green crop is made to precede a turnip crop. The existence of these crops may be taken as evidence in favour of heavier crops of grain. Instances of this advanced mode of culture were not single, but general. Another very perceptible result, to which we have frequently directed attention, is the quickened pace. Not only are the operations in question themselves better done, quicker done, less expensively done, but all kindred and collateral movements have had imparted to them a speed and "whir" characteristic of steam; men acquire the habit of doing the day's work in the day, and of not leaving it for the morrow. The day's labour, too, on a steam farm represents more work, with less distress to the physical frame of the labourer, and better remuneration. Steam is working a revolution, slightly manifested as yet, so that we can speak only of tendencies in farm practice, and in the character of the rural population; they are being trained for the age of machinery in agriculture. Together with celerity of motion must be coupled accuracy, reliableness, promptitude. The results of well-directed machinery approach a certainty, which is no small advantage when one crop is made to succeed another with scarcely a day's interval.

Upon lighter land it has generally been considered that steam had no *locus standi* whatever; and its progress hitherto in such districts is apparently very small. It seems to have been assumed, as we consider somewhat hastily, that land ploughed easily by a pair of horses is no place for steam. Those light-land farmers, however, who have tried steam, even with the apparatus adapted to heavy land, have arrived at a different opinion. Deep culture, which relieves a wet soil in a rainy season, relieves a light burning soil in a dry season. Though a light soil may not be benefited by inversion, it generally is by deep stirring.

Steam has been applied to light land hitherto under great disadvantages. The first attempt of our steam-plough inventors was to win their laurels on stiff soil: the execution of the greater task comprehended a proof of power to do the less. No one knows what may be done on light land until experience has been gained in the use of implements expressly adapted to it. Some of the examples furnished show clearly enough the results obtained on light land, even with a heavy-land set of tackle, particularly No. 30. Since we went through Norfolk a double-engine set of Fowler's Winding Tackle has been at work upon six different farms with a 6-furrow plough and a 90-inch cultivator. Mr. Clare Sewell Read, M.P., has given a detailed report of what has been done; other reports have followed, all of which go far to show that steam is only awaiting the manufacture of the proper implements to be as great a help to the light-land as to the heavy-land farmers. With the double-engine set of tackle, too, the direct pull upon the implement which is always approaching the engine, enables the maker to try implements of even larger dimensions than those already in use. The independent method of removal is much in its favour, while the large undivided areas common in light-land districts enable it to work to the greatest economy.

The hindrances are multiform. They lie principally with the landowners and the tenant-farmers themselves.

There are bright exceptions to the rule; but the rule speaks to the general indifference, as regards the introduction of steam, of those who own the land of this country. Some are such entire sportsmen as almost to ignore other considerations; they therefore insist on retaining the straggling hedgerow which may hide the hare, or the stubble that affords cover to the partridge. Stringent rules not unfrequently came under our notice which debar the tenants from mowing their corn crops, and from breaking up their stubbles until the autumn is too far advanced for the employment of steam: such restrictions seem to us most damaging to the progress of steam culture.

Before steam can be as generally used for tillage as it is for

thrashing, the fields below 10 acres must be enlarged, and areas of 30 and 40 acres become more the rule than the exception. When it is learned that in the cultivation of small fields a ½ cwt. of coal is consumed per acre beyond the quantity consumed in large fields, and that, as in Mr. Bott's case (No. 12), 1 acre is lost per day as compared with the work done by Mr. Impey in larger fields, there will be natural hesitation to commence under such disadvantages. It may be objected that a blow is here aimed not only at the hedgerows, but at the timber, and that the timber is essential as a protection to the land, besides being a source of profit. This view of the question has not escaped us. We are far from desiring to denude the country of timber, but we think it is possible to remove it from a position where it is of small value and of great detriment, and so dispose of it as to be not only more ornamental, but better calculated to check the winds which sweep a country from known quarters. If the trees which obstruct progressive agriculture were banished from the hedgerows and ornamental clumps, plantations and belts, adopted with judgment and taste, we conceive that all parties would be best served, and the eye of the lover of woodland beauty by no means offended.

There are other hindrances, such as the want of a better system of tenant-right, leases with stringent covenants, and customs of the country, which may have been admirable when they were adopted, but are far from being adapted to the present times. Thus the 4-course system, though well calculated to raise an unproductive district to a fair state of productiveness, is not adapted to a state of things in which men find it to their interest to invest 12*l.*, 14*l.*, or even 20*l.* an acre in their hired lands; "the barley is sure to go down after the root-crop, and two white straw crops in succession are necessary." It is the absence of these favouring circumstances which tends at present to check the progress of steam.

There are hindrances also on the part of the tenant-farmer; foremost, as a rule, we are sorry to acknowledge, is the want of capital for the first outlay. Other obstacles, such as his prejudices, his lack of mechanical knowledge, and his timidity, have nearly had their day; for he has found himself shifting with the times and obliged to accommodate his notions to them.

Having endeavoured briefly and generally to express our views on these two questions, we now propose to make a few practical observations on other matters.

Our observations would lead us to advise no farmer to embark in steam-machinery who has so little knowledge of mechanical detail as to be obliged to depend entirely upon his labourers. He should, at least, know enough of the construction of an

engine to be able to drive it. But for this knowledge many of the most successful cases we have reported would, owing to the suspicion and antagonism of labourers, have proved complete failures. A trained mechanic is often a difficult person to manage, while an untrained labourer is dangerous.

Piece-work in steam culture is not always to be recommended. Some farmers who have tried it say that the work is more quickly done, but that it loses in thoroughness, and there are more breakages. For instance, Mr. Arnot (No. 29) considers that piece-work is "scamped."

As to the several parts of the apparatus, we have observed too commonly in the engines a want of sufficient steam-space. Then the proper pace in driving is not sufficiently attended to. An engine-maker adapts all the parts for the performance of a certain number of revolutions per minute, and the nearer this normal speed is adhered to the more duty is got out of the engine; therefore it is bad policy to make the number of revolutions irregular by too great stress of work—rather decrease the load, to keep up the speed. The greatest injury done to engines is not in ploughing, but in shifting; the rapid reversing, so often most carelessly done, is that which most tries an engine.

One point worthy of notice is the benefit derived from the use of Le Franc's liquid, an account of which is given in the report of Mr. Lancashire's farm (No. 32). The necessity of smith's-shops, engine-houses, and other conveniences, requires more attention.

The question between the cultivator and the plough is not to be very easily settled. We have come to this conclusion, however, that a plough is a very valuable adjunct to a cultivator, enabling the engine much to enlarge the sphere of its action. There are seasons when a cultivator cannot be worked to advantage, but when a plough certainly can; and the absence of a plough operates as an excuse for the keeping of more horses than are really required. We found among those farmers who have hitherto employed cultivators only, a general desire to have a plough in addition; we also found that those farmers who have ploughs, used them.

The ropes made during the last few years are of much improved quality. Mr. Arnot says that ropes of 1861-2 are twice as good as those of 1859. We subjoin information obtained from Messrs. Glass and Elliot, 23, Great George-street, Westminster, on this important subject.

Their foreman states that improvements have been made of late in the machinery, rather than in the way of manufacturing the steel-wire ropes, and that their greater uniformity of temper and extra toughness has given them an increase in strength of more than one-third over those sent out in 1860.

As plough-ropes are subject to much friction, and the larger the wire the more friction the rope will stand, the wires should be as large as the sheaves and drum will permit, and the latter should afford space enough to admit of the rope being made with four strands.

Again, if very small sheaves and drum be used, the constant quick bending, in coiling off and on, will cause the rope to wear out much sooner than it would were the sheaves and drum of a larger size.

The ropes in the greatest demand as being suitable for most kinds of ploughing are made of No. 15 gauge wire, with six wires in each strand, and four strands in the rope.

The principal sizes used are as under:—

Gauge.	Average Breaking Strain of Wire in Cwts.	Rope made with 6 Wires in Strand, and 6 Strands in the Rope.		Rope made with 6 Wires in Strand, and 5 Strands in the Rope.		Rope made with 6 Wires in Strand, and 4 Strands in the Rope.	
		Circumference in Inches.	Breaking Strain in Tons.	Circumference in Inches.	Breaking Strain in Tons.	Circumference in Inches.	Breaking Strain in Tons.
14	12	$2\frac{1}{2}$	26	$2\frac{1}{4}$	$22\frac{1}{2}$	$1\frac{7}{8}$	18
$14\frac{1}{2}$	$10\frac{1}{2}$	$2\frac{3}{8}$	$23\frac{1}{2}$	$2\frac{1}{8}$	$19\frac{1}{2}$	$1\frac{13}{16}$	16
15	9	$2\frac{1}{4}$	20	2	17	$1\frac{3}{4}$	$13\frac{1}{2}$
$15\frac{1}{2}$	7	$2\frac{1}{8}$	$15\frac{1}{2}$	$1\frac{1}{8}$	13	$1\frac{5}{8}$	$10\frac{1}{2}$
16	6	2	$14\frac{1}{2}$	$1\frac{3}{4}$	12	$1\frac{1}{2}$	10

The price of these ropes would be 75*s*. per cwt., delivered carriage paid.

The subject of "depreciation in value" of apparatus may be studied in the data furnished in the Reports of the steam culture of Mr. J. L. King, of Scole (No. 20), and others.

As an illustration of the relative extent to which some farmers use their steam apparatus more than others, we give the number of acres to each pair of horses still kept in conjunction with steam in a variety of instances.

Thus in our light-land section—Mr. Ellman has a pair of horses to each 70 acres; Mr. Lancashire, to 100 acres; Mr. Arnot, to 132 acres arable; Mr. Smythe, to 100 acres; and Mr. Woods, to 50 acres arable.

On medium soil—Mr. J. L. King has a pair of horses to each 75 acres arable; Mr. Greene, to 133 acres; Mr. Palmer, to 66 acres; Mr. Battcock, to 70 acres; Mr. Ruston, to 80 acres; Mr. Bott, to 84 acres; and Mr. Cooper, to 90 acres. Mr. Cooper, before the steam cultivation came, had a pair to every 60 acres.

Our opinion is that the presence of a 10-horse power steam-engine on a farm ought to reduce the number of horses formerly kept to a pair for every 100 to 120 acres arable.

Perhaps we can hardly limit the precise number of acres on which we should recommend the purchase of a steam apparatus, but our impression, from what we have seen, is that there should be 350 acres arable of heavy land, or 500 acres of lighter soil; but some are guided by the employment they have for the engine at other work.

HOWARD REED,
Secretary to the Committee.
JOHN J. HEMSLEY,
Shelton, Newark, Notts.
JOHN HICKIN,
Dunchurch, Rugby.

MR. J. A. CLARKE'S REPORT.

Report of the 2nd Inspection Committee deputed by the Royal Agricultural Society of England to inquire into the Results of Steam Cultivation in the Counties of Northumberland, York, Lincoln, Nottingham, Stafford, Salop, Flint, Montgomery, Worcester, Warwick, Gloucester, Somerset, Dorset, Wilts, Berks, Oxford, Bucks, Bedford, and Northampton.

THE experience of some 140 practical farmers upon an area of 66,000 acres arable,—consisting of holdings of all sizes, from less than 200 up to 2500 acres, and averaging 536 acres each; embracing a great diversity of soils, and situated in the most varying climates, from the droughty east to the rainy west, from the chilly north to the sunny south; an experience derived from four up to ten years' employment of all the different forms of apparatus now in use, under every system of working, and with every style of management; an experience also, for the most part, investigated upon the spot by ten business men, whose names and reputation are staked upon the truthfulness and impartiality of their Reports,—ought to establish the success or demonstrate the failure of steam tillage in this kingdom. And the Society's munificent outlay upon the Inquiry will be sanctioned by results, if only a small percentage of its Members and of the proprietors and tenants of land still under horse culture shall be led by the mass of evidence concentrated in the three Reports to treat their fields as well as their produce by the power of the steam-engine.

As far as *our* part of the enterprise was concerned (that is, in visiting and reporting upon selected "steam-farms" in the nineteen counties named above), we felt that every idea of a competitive nature was foreign to our purpose; we travelled some thousands of miles by rail, by road, and on foot, not to draw comparisons between this "set of tackle" and that, but to witness and examine, on behalf of the Society's Council and Members, what steam tillage is actually doing for the farmer under a great variety of circumstances—to describe what we ourselves observed, to collect statistical information on which we considered that we could rely, and to note results communicated to us in good faith, leaving every reader to draw his own conclusions from the facts related, as to which particular piece of machinery (if any) will be best adapted to his own case. Still, if we properly appreciated what we saw, and were discreet in the use of our materials, we should be enabled to point out the respective advantages and deficiencies pertaining to the several "systems;" to compare the "one-engine" and "two-engine" arrangements for different purposes, to offer an opinion upon the merits of individuals or joint-proprietorship of apparatus, and of contract-working and letting-out by private owners or companies; and in general we should be in a position to say why it is that adopters of steam culture have been counted by a few hundreds, instead of being found scattered through the length and breadth of our country by thousands.

To narrate the incidents of our many journeys through districts of widely-differing features in landscape and husbandry, would be only an abortive attempt at rendering dry details readable, besides absorbing too much space in the closely-packed pages of the *Journal:* therefore we plunge at once into facts and figures; and the reader who has not the patience to wade through all, can content himself with making use of the "concluding references" at the end of each Section. We purposely avoid the perhaps too customary generalization of statistics in tabular forms, giving "average" items of expense, "average" performance per day or year, "average" number of horses displaced, and so on. For certain purposes, wholesale deductions of this kind may be valuable; but our investigation has been essentially of a more retail character. We have sought to ascertain what steam tillage is doing upon each particular farm where we found it: the outlay, the working, the results may tell better or worse on that farm than on another; but they concern that farm alone, and are accounted for, commented on, justified or condemned, by the special conditions and circumstances surrounding that particular case. The details of cost and profit, of suitability of the machinery employed, of effects upon the soil and the cropping, will

be true of all similar farms under like management; whereas general averages totalled up from a multiplicity of dissimilar farms under all sorts of circumstances, are true of no one instance, and are applicable only to an ideal case that does not exist. We prefer that each farmer's experience shall stand on its own merits and speak for itself: but, for the sake of symmetry and harmony in our Report, the farms are classified, as far as practicable, according to the character of their soil, still further grouped according to climate, and subordinately arranged, pretty much according to the size of the occupation; while joint-partnership in apparatus, and, again, the hiring system, are treated of in separate Sections. This plan of subdivision will enable the reader to select for perusal the story of that class of farms in which he may be most interested; and, at the same time, a consultation of the "reference-tables" will assist in finding the various items of information scattered through the Report upon any special topic sought for.

Repetition will be avoided by our explaining in this place the bases adopted in our several calculations. Working expenses for "manual labour," "coal," "oil," &c., are, of course, those given us in answers to the Society's *Schedules of Queries*, or were gathered by ourselves from the employers or their workmen. The value of "horse-labour," differing extremely according to management, ought strictly to be taken at what it actually costs in each case; but as only an arbitrary value can be assigned to a large portion of horses' food, opinions varying so much that no two farmers reckon up the cost of their teams upon like *data*, we have deemed it sufficient for the use of this Report to take the averages furnished by the Society's own authorities on the subject. Besides, our estimates of gain by displacement of draft animals do not profess to be exact, but to be near enough the mark for affording us general conclusions. Mr. J. Chalmers Morton, in his essay 'On the Cost of Horse-power' (Journal, vol. xix.), gives a tabular synopsis of the various particulars of keeping no fewer than 282 horses upon twenty-one farms; the average being for food, 23*l.*; blacksmiths', saddlers', farriers' bills, and depreciation (or maintenance of value unimpaired), 5*l.* 10*s.*, or 28*l.* 10*s.* per horse; to which are added, annual wear of implements, 3*l.* 2*s.*, and share of wages of team-men, 14*l.* 8*s.*; making a total of 46*l.* as the yearly cost per horse. Mr. Frere's valuation, in his paper on 'The Present Aspect of Steam Culture' (Journal, vol. xxi.), is 41*l.* per horse. Considering that, on the one hand, higher prices of corn and better wages now tend to raise these estimates, while, on the other hand, making the needful allowance for the worth of the horses' manure, will reduce them, perhaps we shall be very near the mark if we divide

between the two, and assume the total average expense of a farm-horse to be 44*l.* a year.

The cost of ox-labour is a matter of still greater diversity of opinion. Mr. Cowie, in his Essay 'On the Comparative Advantages of Horses and Oxen for Farm-work' (Journal, vol. v.), estimates it at 17*l.* 10*s.* per year,—taking turnips at 10*s.* per ton; however, he omits, on the one side of the account, the wages of the team-men, and, on the other, the yearly improvement (instead of deterioration) in the value of the animal. Mr. Ellman (quoted in Morton's 'Young's Farmers' Calendar,' 1862) calculates the keep of a team-bullock to be half that of a farm-horse. To be within the bounds of extreme moderation, we have charged 15*l.* as the total yearly cost of a working ox.

"Interest upon capital invested," we put up at the usual figure of 5 per cent.

The complicated and difficult items of "wear and tear," and "depreciation in value" of the machinery, we have ventured to treat in a somewhat new method. In the Society's Reports of Steam-Plough 'Trials,' the Judges were obliged to assume some arbitrary percentage upon first outlay before they could frame any comparative estimates of the cost of work done. Thus, in the earliest experimental trial at Boxted Lodge, in 1856, the steam-plough was debited with 15 per cent. for "interest and wear and tear," distributed over 1000 acres, "to be ploughed annually on a farm of 600 acres." At Salisbury, in 1857, no official calculation was attempted. The Chester Judges, in 1858, charged both Ricketts' rotary digger and Fowler's plough with "interest 5 per cent., and wear and tear 15 per cent., on first cost, taking 200 as the number of working days per year," and dividing the yearly sum into so much per day: while they charged Howard's cultivator with 5 per cent. interest, and wear and tear 20 per cent.: a distinction not warranted by after experience, this same tackle being now at work in Huntingdonshire, and having cost very little in repairs. At Warwick, in 1850, no estimates of expense were made. In the Canterbury trials of 1860, the Judges took the interest at 5 per cent., and wear and tear in all cases at 15 per cent., on cost price of apparatus, dividing the amount over 200 working days in a year. At Leeds, in 1861, interest was reckoned at 5 per cent., and wear and tear, in Fowler's case, at 12½ per cent., and for Howard's and for Kirby's apparatus 15 per cent. on the purchase-money, divided among 200 working days. The next calculations were made at Worcester in 1863, the interest being taken at 5 per cent., and wear and tear at 12½ per cent. in all cases; and apportioned upon 200 days in a year. And in the last trial at Newcastle in 1864, the Judges followed the same figures. Now, what will be the average cost of a

steam cultivator for maintenance in a course of years can only be arrived at from the history of a great number of machines, extending over a protracted interval of time; and ultimately, when steam cultivation is a quarter of a century older, we shall be able to say such and such an apparatus has so many acres of work in it, just as railway managers can assign the total number of miles that a locomotive is expected to run. We have reflected, however, that the arbitrary and gratuitous allowances for "wear and tear" are separable into two distinct items—"repairs" and "depreciation" in value. Steam-ploughs have been in existence long enough to give us trustworthy data for the first; and, therefore, instead of endeavouring to get one general percentage for repairs, we state them at what they really are—whether consisting of the ordinary renewal of wearing parts (as rope, shares, pulleys, brasses), and parts consumed in working (as grate-bars, fire-boxes, &c.), or of replacements arising from accidental or other breakages—of course distinguishing between these and additions of improved parts, which are simply augmentations of the first cost of the machinery. There is left an uncertain item of gradual "depreciation" in value of the framework, &c., or those main parts of the apparatus which are not constantly maintained at their original worth by renewals and replacements. And we have to ascertain what is the average length of life of a steam-plough. Where so much depends upon the amount and character of the work done, the intervals of rest (and rust), the quality of the water used, the care and intelligence of the engine-driver and workmen, and also upon the inherent difference between two engines turned out of the same workshop (says Mr. H. Evershed in his Essay 'On the Wear and Tear of Agricultural Steam-engines,' Journal, vol. xxiii.), it is impossible to fix upon any general percentage likely to be true in a majority of cases. Mr. R. Vallentine, in his paper on 'The Comparative Advantages of Fixed and Moveable Steam-Power' (Journal, vol. xxiii.), does not attempt to separate repairs from depreciation, but lumps them together in "cost of maintenance" at fully 20 per cent.; which, however, he says, is too much if applied to the work of thrashing on one farm. Mr. Frere (Journal, vol. xxi.) does make the distinction, allowing, after all repairs are paid for, 10 per cent. for depreciation, besides 5 per cent. for interest. Mr. Turnill (quoted by Mr. Frere), from his experience with three portable thrashing-engines at continual contract-work, thinks that the engines will be unfit for use in 10 or 12 years, and that 10 to 12½ per cent. should be set down for depreciation. Mr. Evershed, after stating the repairs of twenty portable engines, computes the depreciation in this way:—A ten-horse portable is purchased for 290*l.*, what will it be worth in 10 years' time?

Let us say 50*l*; thus there is 240*l*. sunk. The annuity which this sum would buy for 10 years (calculated at 5 per cent.) is 31*l*. 2*s*.; to this annual item add 2*l*. 10*s*., the yearly interest of the 50*l*. that the engine is worth at the end of the time, and you have altogether 33*l*. 13*s*. per *annum* as the combined interest and depreciation upon capital invested. This is equivalent to about 11½ per cent. on the original cost; or, in other words, if you put down 5 per cent. as "interest," there will remain 6½ per cent. as "depreciation." However, the test of saleable value can hardly be applicable to the case. A ten-years'-old engine, that might sell for 50*l*., is worth far more than that to its owner, seeing that it is still capable of doing all his work; and it would realize a much higher price if the purchaser were not uncertain about the real condition of a second-hand engine. There is no regular market-value for old engines, any more than there is for straw which a tenant is forbidden to sell. In the case of the latter article we are accustomed to distinguish between "commercial" and "consuming" value: and we should apply the same principle to steam-power apparatus; the question being, not "What could I sell a 'second-hand set' for, when one day's use of it alone may have rendered it no longer 'new,' and has knocked off a fourth of its market value?" but "What is it worth to me; or, in other words, in what proportion is it a weaker and more hazardous machine than when it came fresh from the maker?" In the earlier years of steam-ploughing perhaps it was fair to expect a machine to be antiquated in a few years' time by the rapid progress of invention; so that both Mr. J. Chalmers Morton, in his numerous and exhaustive reports of "steam-farms" (see a selection from them in his 'Farmers' Calendar,' 21st edition, 1862), and Mr. J. Algernon Clarke, in his 'Five Years' Progress of Steam-Cultivation' (Journal, vol. xxiv., 1863), may have been justified in guessing at 10 per cent. per annum on first cost, for "depreciation" or "maintenance of value," besides the actual "repairs," and 5 per cent. for "interest." In this year 1867, however, the various forms of steam-tillage machinery are so thoroughly established that, so far from their being likely to be superseded and thrown aside as altogether worthless only ten years after their purchase, we may fairly reckon that they will last until worn out, or perhaps until piece-meal replacements of new working parts, new boiler-plates, new tubes, &c., may be considered as starting the apparatus new again,—the same in identity, yet completely renewed in substance, like the old lady's bellows or the Irishman's clasp-knife. That 10 per cent. is far too heavy a charge, appears from the very fact of there being sets of tackle manufactured ten years ago still working, and betraying no sign of being now on their last legs. We have seen apparatus

of this age, regularly and extensively employed, yet with frame-work, axles, drums, shell of the boiler, &c., &c., apparently little damaged, with many years' work still remaining before them, and little prospect of their being "out of fashion" for a long time to come. And we therefore consider ourselves warranted in adopting (what must of necessity be an arbitrary figure) 5 per cent. for "depreciation." But we do not calculate even this reduced percentage upon the whole of the original purchase-money. Wearing parts are bought with an engine, but they are from time to time restored perfectly new again under the expense of "repairs," renewal of rope, and so on; so that there is absolutely no depreciation whatever in their value. Mr. J. Chalmers Morton (see 'Farmers' Calendar') deducts the price of the rope, which is kept good in perpetuity by occasional purchases of new lengths, and then reckons "depreciation" upon the remaining portion of the original outlay. This we consider to be the right principle of procedure; but, properly, it should be carried further. We ought to divide the various members of the apparatus into two classes: (1) permanent parts, and (2) wearing and consuming parts; the first including the immoveable framework, and all parts of the structure which are not subject to attrition or consumption in the act of working: as the shell of the boiler, framing, brackets, &c.; while the second class comprises rope, shares, coulters, porter-wheels, pulleys, brasses, bushes, pitch-chains, toothed-wheels, cams, clutches, rubbing parts of the engine, together with grate-bars and fire-box, &c. It is difficult to say where to draw the line, because even boiler-plates corrode in time, and are liable to great injury from noxious water; but we illustrate the distinction that it may more plainly be seen how the item "repairs" does save from deterioration a very considerable proportion of the whole apparatus. And when the cost of these continued renewals has entered into a calculation of expenses, it is manifestly unfair to charge it over again by reckoning the percentage of depreciation upon the constantly sound, because repaired, parts as well as upon the unrepaired, and therefore gradually deteriorating parts. From the cost of the entire apparatus, then, we deduct the cost of the rope, and an allowance (arbitrary, of course, but purposely low, so as to be within the bounds of extreme moderation) for the parts which wear in working and are renewable under the head "repairs," and take 5 per cent. upon the remainder as the annual rate of "depreciation."

Of course the necessary 5 per cent. more for "interest" is reckoned upon the whole of the purchase-money.

This has been a rather long story; but it has been necessary to enter somewhat fully into the question, seeing that the expense of working machinery worth 500*l.* to 1500*l.* or more, and

this for only some of the days in a year, depends greatly upon the standing sum due upon the investment. Moreover, it is high time to disabuse ourselves of the early impression that steam-tillage apparatus is novel, and therefore to be loaded with the highest percentage that doubt and distrust can decently lay upon it; for, on the contrary, it is now old-established, with settled experience on its side, and amenable to the same ratios of calculation that are applicable to other mechanism.

One remark we would add,—that if we do treat steam field-machines too favourably, at any rate we bear with equal lightness upon all, and our moderate allowance for gradual destruction and going out of fashion will be as fair for one maker's "set" as for another's.

The "method" of our Report will be as follows:—

SECTION I.—MEDIUM AND LIGHT-LAND FARMS.
SECTION II.—HEAVY-LAND FARMS.
Division 1.—*East.*
Division 2.—*West.*
Division 3.—*South.*
Division 4.—*North.*
SECTION III.—PARTNERSHIP.
SECTION IV.—THE HIRING SYSTEM.
CONCLUSION.

SECTION I.—MEDIUM AND LIGHT-LAND FARMS.

Comparatively little of really light soil under steam cultivation has been seen by this Committee; and some of the lightest was on farms to be described in "Section III.;" so that we place in the present "Section" merely a few farms which could not be very well classed as "heavy." And in each climatic district (not of England and Wales, but of our 19 counties), we will take these farms pretty much in the order of their size, beginning with the smaller and advancing to those of larger acreage.

Division 1.—*East.*

No. 34. Mr. J. F. Edwards, of Tanholt Farm, Eye, Peterborough, Northamptonshire, has had eight years' experience of steam husbandry, upon a farm of a little over 300 acres arable and 100 acres grass. The surface is level, or but slightly undulating, presenting a scarcely perceptible slope, only a few feet elevated above the great horizontal plain of the fens; and the inclosures are of considerable size, open ditches few, and the low thorn fences generally clear of timber. Good roads, a new covered homestead built in handsome style, and a model farm-house, are other advantages enjoyed upon this holding.

The soil is a deep loam free from stones, resting in some places upon a clayey subsoil with drift gravel below that, while in other parts of the farm the loamy staple lies directly upon the gravel; and a small slice of the farm is "skirty," that is, partaking of the peaty nature of the Fen. Much of the land has been pipe-drained; the gravel subsoil, however, is very porous, so that ridge and furrow are unnecessary; and (a convenience for steam cultivation) water can be obtained anywhere by digging, at 6 or 8 feet from the surface. Mr. Edwards has, of course, provided himself with field wells for the use of the engine. We should add that the annual rainfall here is about 24 inches. Pair-horse ploughing has always been practised on this farm, the average depth of the tillage before steam-power was used having been 4 inches; and this, says Mr. Edwards, was "hard work, often having to wait for rain."

In 1858, when steam tillage was in favour only with men of advanced ideas or (like the occupier of Tanholt Farm) of a decided taste for mechanics, Mr. Edwards ventured upon the purchase of a set of the Woolston tackle, consisting of a four-wheeled windlass, ropes, porters, &c., and a three-tined and a five-tined grubber, to which he added a Fowler 3-furrow plough, with a Hornsby's 8-horse portable engine; the cost of the whole being 500*l.* No difficulty was experienced in teaching the ordinary farm-labourers to manage the apparatus; excepting that, just at first, the men not being up to their work, "murdered" the rope. The engine-driver (John Bugg, a veteran of seventy-seven years), had previously driven a steam thrashing-machine. The hands necessary to work the cultivator are three men and three lads, that is, one engine-driver, one windlass-man, one man on the implement; two lads at 1*s.* 2*d.* per day each, to shift the anchors, and one boy to move the rope-porters. In no other instance have the Committee found such light hands employed to shift the anchors and snatch-blocks; and this circumstance, coupled with the single boy for the porters, points to tillage operations conducted without any very great strain, and to anything but a rapid rate of performance. However, the apparatus is "manned" at the low figure of 10*s.* a day, the ordinary labourer's wage in the district being, 2*s.* a day. Of course, the cultivating men are employed in various occupations on the farm, when the steam-engine is not going. That the steam work is not of a very heavy description appears from the fact that the single-cylinder 8-horse Hornsby engine is run at only 50 lbs. pressure, consuming 8 cwts. of coal (at 15*s.* per ton delivered in the field), and evaporating "three loads of water" in a day. Mr. Edwards undertakes large-sized plots with one laying-out of the rope. We saw a field of 28 acres, which is

cultivated at one "setting-down," that is, without removal of engine and windlass from their position midway along one side of the field, but with the rope inclosing half the area at one time. The *maximum* length of rope out has been 1760 yards; and from four to eight small porters are used in the track of the implement, according to the length of the field. With the 3-tined grubber, the tackle will "smash up" 5 acres a day; with the 5-tined grubber, in crossing already-tilled land, an average of 8 acres per day. The depth of work is from 6 to 10 inches. The 3-furrow Fowler plough is worked at a depth of 5 or 6 inches; and this is declared to be "the easiest job" done by the engine. Removal of the apparatus, from finishing in one field to beginning work in another, occupies about four hours; and takes all the hands, with 6 horses,—3 horses to the windlass, and 3 horses to the engine, which weighs empty 2 tons 12 cwts. One hour is required to get up steam. The extent of Mr. Edwards' operations has been about 200 acres in a year, broken up, crossed, or turned over by the plough; the actual area in different years varying with the nature of the seasons, the rule being to persevere with steam tillage "while the ground remains sufficiently dry." No accurate calculation can be made of the total cost of the work; because the details of expenditure have not been recorded. But Mr. Edwards states that his annual repairs, executed by a village blacksmith, have been "trifling;" the breakages have been "nothing material;" he has met with "no difficulty," and "only had trifling hindrances;" and the first rope, or the chief portion of it, has lasted over 1800 acres, costing therefore about 8*d.* per acre. The drums are now coiled with the second rope; and the wires of this we observed, are about half-worn through. Exclusive of the undetermined "trifling" repairs, the cost of labour, water, coal, oil, shifting, and renewal of rope, amounts to about 6*s.* 8*d.* per acre for smashing up with the 3-tined cultivator, and about 4*s.* 2*d.* per acre for crossing with the 5-tined cultivator.

The apparatus is not let out on hire; but the engine is employed to do all the thrashing of the farm. In the absence of data as to the precise cost of repairs, the amount of work done by the engine alone, and so on, we cannot calculate the total cost of steam tillage in this example. The price of the tackle was 500*l.*; the interest upon this at 5 per cent. will be 25*l.* per annum—depreciation, at 5 per cent., upon a portion, say 400*l.* (the rope being already stated to be renewed for about 8*d.* per acre, while the repairs of wearing parts are not stated), will be 20*l.* And then if we may set off the cost of the repairs against the lending of the steam-cultivating engine for barn-work, we have only to apportion this 45*l.* upon about 200 acres worked in a

year, making 4*s*. 2*d*. per acre. That is, the total cost of steam tillage may be safely stated at 9*s*. to 12*s*. per acre. It is probably less; for the earnings of the engine must be much more than sufficient to cover the light "repairs."

Mr. Edwards has not ridged up land for wintering, or in preparation for green crops; but he has hauled harrows by the rope, both before and after a drill. And he has worked a steerage-drill in wheat-sowing, when the ground was too wet for the trampling of horses. This, however, he says is "not a paying job;" it is too light a task for a ponderous tackle to undertake, but was nevertheless an advantage in a dreadfully wet time. The principal operation has been breaking-up stubbles in autumn to lie rough all winter for a fallow crop, and again stirring the same ground in spring. Mr. Edwards has completed the tillage of fields by steam-grubbing the headlands; but as a general rule, he does not delay more important work for this purpose; he finishes by horses. But we notice that the headlands about 8 yards in breadth, are by no means so well cleaned as the rest of the land.

The benefits of steam culture on this farm are easily summed up. In the first place, 13 horses used to be kept upon 240 acres arable; and now 60 acres more have been brought under the plough, the force of horse-flesh due to the 300 acres arable is (at the same rate) about 16. But 9 horses only are now found sufficient for the work left undone by the engine. The food and depreciation in value of a horse, his cost in blacksmiths', saddlers', and farriers' bills, the annual wear and tear of the implements he works, and a part of the wages of the team-men who drive him, we take at 44*l*. per annum (see our Introduction to this Report): and the seven horses displaced thus represent a saving of 308*l*. a year. The total outlay for a year's steam cultivation may be approximately stated at (200 acres × about 12*s*.) about 120*l*.; leaving a clear gain of about 188*l*. a year from employing steam in place of horse power.

No difference has been made in the manual-labour bill of the farm. It is worthy of note that, while the men's wages for executing the steam-work come to about 20*l*. a year, the cost of the men who formerly worked the nine banished horses was about 130*l*. a year. Hence, both steam and horse work alike costing some 2*s*. per acre, we see that fewer acres are now tilled in a year,—the engine doing at a stroke what formerly required a series of operations.

Mr. Edwards' testimony is that "the work is better done, the land is more forward, not so starved; and the crops are better." The greatest advantage is found upon his strongest land; the badly-drained ground is now the best. The texture of the soil

is altered, so that it ploughs easier every year; two horses now ploughing 5 or 6 inches deep. A 4-course rotation had always been followed; but now, with steam culture he "can do more;" and we are not surprised that he reports "no objections, and should not like to farm without steam." Mr. Edwards says that he has cured a field of thistles; we found oat-stubbles after turnips remarkably clean, to be broken for wheat; we saw fine pieces of mangolds, carrots, and a wonderfully great crop of thousand-head cabbage (being fed off by sheep through slat hurdles leaning towards the crop and frequently shifted); and one field not exactly in garden style was very naturally a wheat stubble following a two-years' layer of ryegrass.

The only thing amiss in Mr. Edwards' case is that he would much prefer having a 10-horse instead of his 8-horse engine.

No. 35. Mr. J. Martin, of Wainfleet, Lincolnshire. A few words only will suffice for this case; Mr. Martin having had only one-and-a-half years' experience with a second-hand apparatus, consisting of a Tuxford and Sons 12-horse engine, separate windlass, Fowler 4-furrow plough, and 7-tined cultivator. The original cost was 380*l.*; and no repairs have yet been needed.

The farm of 460 acres has 260 acres arable of alluvial loam deposited by the sea, with a subsoil of "silt" or ancient tidal mud and sand. And 2 horses can plough an acre per day, 6 inches deep. The surface, perfectly horizontal like all the marsh land thereabout, has been arranged in fields averaging 22 acres in size. Mr. Martin used to keep 14 farm-horses, but on purchasing the steam plough, sold off 4.

The working expenses of the apparatus are—labour (5 men and 2 boys) 14*s.* 6*d.* a day; removal by 9 horses, occupying 3 hours; carting of 800 gallons of water, 4*s.* a day; oil, 2*s.* a day; and half a ton of coal at 14*s.* a ton, *plus* carriage 5½ miles. The work done per day is 7 acres of ploughing or of digging, or 10 acres of cultivating. The engine is employed for thrashing, grinding, and sawing.

Of course, time is yet wanting to say what effect the *thoroughness* and *timeliness* of steam culture have upon the whole economy of tillage and the acreage and yield of the different crops; but the cost per acre of the several operations is probably more than it would be by horses.

No. 36. Mr. Francis Sowerby, of Aylesby, Grimsby, Lincolnshire, occupies 650 acres arable, and 250 acres grass, in the gently undulating "diluvial" or "drift" district between the chalk Wolds and an alluvial belt of marsh land next the sea. The soil is a loam, lying upon a clay subsoil, and makes rather hard pair-horse ploughing. The farm is in large fields, 20 to 30 acres each and more, having been enlarged for steam cultivation;

the land is pipe-drained, and the ploughing "on the flat." Mr. Sowerby has a Ruston and Procter's 10-horse portable-engine; started a "Smith" tackle in 1859, and after working it five years, exchanged it for a "Howard" set, with a 3-tined and a 5-tined cultivator, taking 3 feet and 4½ feet breadth respectively, to which he has since added a set of steam harrows. His reason for "giving up Smith" was because he found "once over with Howard to be not quite but nearly as good as twice with Smith." Here we see what different conclusions are obtained upon different soils: for Mr. Randell (*see* farm No. 67, in the Heavy-land Section of this *Report*) considers the Woolston grubber inimitable for breaking up a clay, while the Bedford tool is better for crossing already-tilled ground. Mr. Sowerby considers 5 acres to be a fair day's work with the 3-tined implement; for which his 5 men and 3 boys earn their regular wages,—engine and windlass-men 2*s.* 9*d.* each, ploughmen and two anchor-men 2*s.* 3*d.* each, and three boys 1*s.* each. For all work over and above 5 acres in a day, the gang gets 3*s.* per acre. Carting about 1000 gallons of water per day costs 2*s.* 6*d.* for the horse, oil costs 2*s.* a day; and half a ton of coal, at 14*s.* 6*d.* per ton, including carriage, 7*s.* 3*d.* a day. Removal, with no fewer than 10 horses and 2 extra men, occupying about four hours, say once a week (as Mr. Sowerby "sets down" to very large plots at once, one field of 48 acres being done from the engine stationed "midside") will cost about 2*s.* 6*d.* on each day's work. We should say, however, that a cheaper plan for moving is for four horses to take the engine, two returning to fetch the windlass, and two to fetch the rest of the tackle. *See* Farm No. 38. These items, collected together, are—

	£.	s.	d.
Manual labour	0	15	3
Water-cart horse	0	2	6
Removal	0	2	6
Oil..	0	2	0
Coal	0	7	3
Working expenses per day ..	1	9	6

Mr. Sowerby estimates his wear of rope at 8*d.* per acre. He contracts for blacksmith's work, and finds it difficult to arrive at the exact cost of repairs; but he thinks that 15 per cent. per annum upon prime cost will cover the several items of repairs, wear and tear, depreciation in value, and interest of capital invested. The apparatus cost above 250*l.*; the share of the engine, which is employed nearly half its time in thrashing the produce of about 300 acres of corn, may be valued at say 180*l.*; and 15 per cent. on 330*l.* will be 49*l.* 10*s.* a year. For the last four years, the apparatus has worked seventy-eight days in each

year; thus making the charge 12*s.* 8*d.* per day. The whole expenditure, then, is as follows:—

	Per Day.			Per Acre.	
	s.	*d.*		*s.*	*d.*
Working expenses	29	6	....	5	10½
Rope	3	4	....	0	8
15 per cent. for repairs, wear and tear, depreciation, and interest	12	8	....	2	7
Total	45	6		9	1½

Of course, the larger acreage per day done with the 5-tined cultivator would cost something like two-thirds, or say 6*s.* per acre. This does not look like very cheap work, if we compare it with the price at which horses can cultivate; but that the steam work is really worth far more than horse work would have been may be very easily perceived. In the first place, it has enabled Mr. Sowerby to sell off 6 out of his former force of 24 horses, and moreover, to bestow less "keeping" upon the remaining 18—which are found amply sufficient to get up his harvest well with the big old-fashioned pair-horse waggons of the country. Six horses, at our standard estimate of 44*l.* each, for maintenance and working, save 264*l.* a year: the annual outlay for steam cultivation is about (78 days × 2*l.* 5*s.* 6*d.*) 177*l.* 9*s.*; leaving a gain of 86*l.* 11*s.* *plus* the saving in maintenance of the remaining 18 horses. But the great thing is that there has been a decided increase in the yield of cropping, since the steam-cultivator started. The drainage, too, is improved; and the root-crops are eaten off with somewhat more advantage.

As one altogether exceptional circumstance, we may mention that from the mere cleansing of one field, Mr. Sowerby considers that he gained as much as 150*l.* in a single year. This 40-acre piece was foul; had it been ploughed it must have become one mat of twitch; whereas, treated by the steam-engine, it gave a better crop than it had ever before produced.

Mr. Sowerby's husbandry is nearly 4-course, sometimes with 2 years seeds; but beans not grown. In autumn he breaks up with the steam-cultivator 150 acres of stubble, and crosses in the spring for green crops. The 18 horses manage the manure-carting, by getting out the dung in early winter, to be laid on the land for roots at sowing-time. Besides the 300 acres of steam-fallow grubbing, 40 to 60 acres of seed-lea are broken up in July by steam for wheat; Mr. Sowerby finding that he thus gets a good crop without weak straw. The great point in steam tillage, he says, is doing the work when dry, and he has no horses on the land from Christmas to March.

He expresses himself very well satisfied with the apparatus, and he is one of those managers who take care of their machinery; his

rope is in good order, and always "dressed" before laying by. Owing to the wet season, it had not been used since July,—this was at the time of our visit, November 12th.

No. 37. Mr. G. B. Skipworth, of Moortown House, Caistor, Lincolnshire, occupying about 600 acres arable (besides 80 acres of pasture), two-thirds light, the rest strong land, situated in a level district, and divided in 25-acre inclosures, has had 3½ years' experience in steam ploughing. He began in June, 1863, with a 12-horse traction engine, built by Richardson and Darley, of Kirton-Lindsey, working a Fowler's separate clip-drum windlass, disc anchor, and 7-tined cultivator; and in January, 1866, he started a Fowler 10-horse engine with 3-furrow plough. The first engine cost 500*l*., and its windlass tackle 350*l*. The Fowler engine cost 550*l*. The repairs he reports as "trifling," and occasioned by "bad castings or inexperience of men." He has paid his engine-driver, 20*s*.; windlass-man, 15*s*.; ploughman, 15*s*.; anchor-boy, 6*s*.; two porter-boys, 5*s*. each; and water-cart boy, 7*s*. per week. One horse fetches water in an iron water-cart, fitted with pump and hose; quantity about 400 gallons per day, but in proportion to the fuel burnt. Oil costs 1*s*. 6*d*. a day; and coal, at 14*s*. a ton, is consumed at the varying rate of 1 to 2 cwts. per acre, according to the work. It requires one hour to "take up" the tackle, and another to "set down:" the anchor being moved by 2 horses, but sometimes without horses. The area ploughed or dug amounts to 3 roods per hour, or about 7 acres a day. The cultivator does 1 to 2 acres per hour, or 10 to 15 acres per day,—an exceedingly good performance. When let out, the prices charged have been 8*s*. to 10*s*. an acre on light land, and 10*s*. to 15*s*. an acre on heavy land. The engine is employed for thrashing, grinding and sawing.

Mr. Skipworth has dispensed with 6 out of 18 horses. His heavy-soil fields drain better after steam culture, and though he has not altered his rotation, he estimates the general increase in the yield of his crops at "10 per cent. and more." We did not visit Mr. Skipworth's farm; but probably if this "10 per cent." were converted into quantities, it might be stated as 2 or 3 tons an acre more of roots, and 3 or 4 bushels an acre more of corn, derived from the steam-plough.

No. 38. Mr. Thomas B. Dring, of Claxby, Spilsby, Lincolnshire, purchased a set of Woolston tackle, with 3- and 5-tined grubbers, and 4-wheeled windlass, made by Butlin, of Northampton, about the year 1858. This he worked by an 8-horse Clayton's portable engine, bought three years before; but was obliged to have the whole remodelled by Ashby of Louth, because of the ropes being "always in the pulleys," and the loss of time in stopping the engine at the land's end. Now, the appa-

ratus is simple and effective; the engine is kept going, and there is no stoppage whatever at the end. Mr. Dring has several farms lying widely apart—between 800 and 900 acres (about one-third grass), part flinty, part strong alluvial and marsh land; ploughing being good two-horse work, but requiring three horses when the ground is hard. The surface is pretty level; and the fields vary from 6 to 26 acres, altered only on one farm, as the round-about system will work into any corner, though, as in the case of horse-ploughing also, not without hindrance. On one occupation Mr. Dring works a second set of tackle—a combination of Smith's and Chandler's method, with a 10-horse engine; not so cheap an arrangement as the other. He has a turn-over plough, though he seldom uses it.

The average day's work, in small and large fields, and including shifts, has been 6½ acres. The daily working expenses are as follow:—five men, including engine-man, at about 3*s.* each, and three boys at 1*s.* each. Sometimes the men are at piece-work, at 6*d.* per acre; the boys being paid by the day in addition. Water-fetching requires a horse and barrel. A shift takes four horses about two hours. Oil costs about 1*s.*, that is for 1½ pint; and of coal about 6 cwts. are burned, at say 16*s.* per ton. When in a large sized field, an 8-horse engine has done 10 acres a day with this consumption; so the work cannot be very hard.

Mr. Dring has not kept an accurate account of the time occupied during a year's work, but puts it at about 40 days. The engine thrashes, but the tackle is not let out after harvest. No trouble or difficulty whatever is now experienced with the apparatus; and, while some people are obliged (from the nature of the soil) to leave off work when rain comes on, Mr. Dring is seldom stopped by rain or wind, as instead of driving by a strap from the engine fly-wheel, he has V-grooved riggers and band, which do not slip, cost no more, and will wear longer.

The results are summed up thus:—better drainage, from breaking into the "sole;" on the better land a greater breadth of corn is grown, and "the crops have been more productive, from being planted at the proper time, and none out of season." This is a very important point—an increase of yield averaged over a whole farm, from the greater equableness of the crops conferred by seasonable sowing. Mr. Dring is one of the extremely few adopters of steam cultivation who have not parted with any of their horse-flesh. He uses the same number of horses as before; and yet is satisfied that steam culture is an advantage to him, because it always brings him "in time with planting corn and root crops."

The data in this example of steam-farming are too few to admit of a calculation of expense per acre or per year, but several

hundred acres are not cultivated for nothing—it may be 6*s.* to 8*s.* per acre. Yet the outlay of perhaps 100*l.* to 150*l.* a year, *in addition to all the horse labour as before*, is considered by a keen and clever man of business to pay well by its results in the cropping. This is worthy the attention of those persons who are fond of judging the value of steam-husbandry by its cost per acre, in comparison with horse work.

No. 39. Mr. John Sowerby, junior, of Beelsby, Grimsby, Lincolnshire, has two farms under steam culture, embracing 1200 acres arable, and 300 pasture; partly strong soil upon clay, and partly light, easy, pair-horse land, upon marl. Most of the arable is level, but a small proportion is light Wold soil on the hills, and worked chiefly by horses. The fields are of 35 to 40 acres each. In the summer of 1864, Mr. Sowerby purchased a set of Howard tackle, for 250*l.*, being induced to do so by the success of a similar set in the hands of his uncle Mr. Francis Sowerby; and in the spring of 1866, a double-cylinder 10-horse engine for 270*l.*, before which time an 8-horse engine had been used and found too weak. No repairs of consequence have been needed, the rope has broken a few times, two or three snatch-block pulleys have been fractured by the engine-man not stopping in time; and the rope-porters worn have been repaired by a blacksmith. The engine is used for thrashing out the grain off 250 acres, but the apparatus is not let out on hire. The cultivator does from 5 to 8 acres a day, the hands being paid 3*s.* an acre when working the "3-tiner," and 2*s.* 3*d.* an acre when working the 5-tiner; the force being five men and two boys, besides the water-boy; removal takes 10 horses and occupies three hours. The water carted is about 1300 gallons, the oil costs 1*s.* 3*d.*, and half a ton of coal burned costs 7*s.*, besides carriage 7 miles.

About 57 days' work were done in the autumn of 1865 and spring of 1866, and the "days put off by bad weather or by breakages" have been few. Of course, it is too soon yet to judge of effects upon cropping. The stronger soil drains better. and Mr. Sowerby has disposed of 6 out of his former force of 40 horses.

Division 2.—West.

No. 40. Mr. C. Sturge, of Bewdley, Worcestershire, works a set of Fowler's "roundabout" tackle (that is with a stationary windlass), purchased in the spring of 1864, for 230*l.*, and costing 15*l.* more for additions. The engine is a Tuxford's 7-horse power portable. The implement is a balance-plough, carrying either 2 or 3 skifes, and this apparatus ploughs about 4 acres, or cultivates 6 acres in a day, upon soil varying from light sand to

strong clay. The fields average only about 15 acres each, although a considerable number of old hedgerows have been grubbed up and new ones planted, and the farm is steep in parts, and also stony.

The working expenses per day are, engine-man, 3*s.*; windlass-man, ploughman, and two anchor-men, 2*s.* 6*d.* each; water-carrier (who generally fetches the water, about 400 gallons, in buckets, from a pump or pool), 2*s.*; and a couple of porter-boys, 1*s.* to 1*s.* 6*d.* each. Oil costs about 9*d.*; and 7 or 8 cwts. of coal at 10*s.* per ton, cost 3*s.* 6*d.* to 4*s.* Moving takes 3 horses and the steam-gang for half a day. The repairs at present have been but little; Mr. W. Hardwick (the agent) "thinks the whole not more than 5*l.*"—consisting in the renewal of a few skifes broken by the stones and roots, and mostly of porter-wheels and pulleys. There are two farms, two miles apart, with a bad, hilly road between; hence, more horses are required, and the tackle is chiefly used on the home-farm, having only 100 acres arable: the two comprise only 180 acres arable, with 250 of pasture; but the engine is employed in grinding corn for the farm, in sawing up rails, pale-fencing, &c., thrashing the farm corn, and also goes out for hire.

The tackle has worked eighteen days in a year; and though it has been stopped a few times by bad weather, there has never been a day's delay from breakage. The farm has been in hand only two years; but by steam culture Mr. Sturge gets more ground planted with roots than he otherwise could; he does with less horses by three than he would have required (the saving of over two horses would more than equal what his total "steam" outlay can amount to) and Mr. Hardwick says "undoubtedly our produce has been greater on account of steam cultivation." *

No. 41. Mr. Richard Pullen, of Shackerley, Albrighton, Shropshire, works a Howard cultivating tackle, with a double-cylinder, 8-horse portable engine, on a farm of about 240 acres arable and 110 grass, consisting of sandy soil upon sandstone rock. His average performance in level fields, made from 10 into 20 acre pieces, is 8 acres a day; burning half a ton of coal, at 10*s.* per ton, using 2*s.* 3*d.* worth of oil, and evaporating 500 gallons of water, carted by one horse. Two of the men are paid 2*s.* 6*d.* each, three men 2*s.* each, and two boys 8*d.* each per day. A shift takes 8 horses for five hours. The engine does thrashing and other work, and also cultivates for neighbours at a charge of

* The steam-tackle has just been turned to good account for getting in 12 acres of spring wheat after turnips sheep-fed. Early this month the field was well cultivated in two days, and drilled on the third day by a Suffolk drill with harrows attached; the land has not been in working order for a single day since; even then its condition was such that the trampling of horses in doing the necessary tillage must have spoilt the seed-bed.—W.H. (March 26th.)

10*s.* an acre once over, and 18*s.* twice over. Mr. Pullen gets more green cropping than he used to do; his crops in general, he says, are more productive, and of his former tillage force of 8 horses and 4 bullocks, he has dispensed with the 4 bullocks. The tackle was purchased in 1863 for 470*l.* (the engine previously bought in 1861); it has been employed about fifty days in each year, and the repairs have consisted of a new rope and some few porters.

No. 42. Mr. W. J. Edmonds, of Southrop, Leehdale, Gloucestershire. Here we found one of the best examples of expedition and completeness of steam tillage within the compass of our whole tour. Mr. Edmonds occupies 1000 acres arable and 200 acres of grass; with a tolerably level surface, and lying in fields of 10 to 30 or 35 acres each, generally large, and with few trees. And with the exception of making more convenient gateways, and so on, few alterations have been needful to prepare the farm for steam cultivation. Lying in an oolite district the land includes stone-brash, rich red-brown sandy loam, and clay with limestone in it, though at considerable depth in a few of the fields, as in them muriatic acid fails to discover lime in the staple. Altogether this is a remarkably fine occupation, with a soil of generally good quality.

In 1862 Mr. Edmonds' father commenced steam-ploughing with a Fowler 14-horse engine and anchorage, upon 2000 acres arable, at once displacing 7 teams, that is, 28 oxen; and 170 acres more of strong arable land were taken without increasing the force of horses. In 1864 the farm was divided between Mr. W. J. Edmonds, and his brother Mr. Giles Edmonds; and on the present holding of 1000 acres arable, only 20 horses are kept, some of these also being old ones. Yet at the time of our inspection (third week in September), and in spite of the wet season, which had delayed tillage operations everywhere (and the backward plight of many farmers is shown in our Report), Mr. Edmonds was quite forward with his work; his clover ley was all ploughed for wheat, and he writes that 50 acres more, after rape and early turnips, were well up before Christmas. Most of the farm consists of "3-horse land," a considerable portion, however, being ploughed by 2 horses to a furrow; and the proper force of horse-flesh to such a farm (managed, but not strictly, on the 6-course shift), without a steam-plough, would be about 3½ horses to each 100 acres; that is, say 32 to 35 horses. Only 20 are now kept; thus the displacement of 12 to 15 horses, at 44*l.* each, amounts to a yearly saving of 528*l.* to 660*l.* And this displacement of teams is agreeable to what it should be, if the engine does all the heavier tillage. For Mr. Edmonds reckons that one-third of the draft-work of his farm is in harrowing and light operations,

and another third in carriage. And that the engine fully takes its share of the labour appears from the fact that it executes 1600 acres in each year, including all the heavy tillage for fallow crops, and the ploughing of more than 200 acres for wheat. In fact, none of the wheat seed-furrow, excepting one piece between 25 and 30 acres, is ploughed by horses.

Exact memoranda of costs and quantities have not been kept since the first year; but generalities will be sufficiently satisfactory in this case. A new "long rope" and new "short rope" are procured in alternate years, the cost amounting to about 6*d.* per acre. Then the repairs (although the simple breaking of a pin once let the engine run backwards into a stone quarry) have been very light, not exceeding 140*l.* a year altogether, including the rope, or about 1*s.* 9*d.* per acre. The first cost, for the 14-horse engine and tackle, 4-furrow plough, and 6-feet wide scarifier, was about 950*l.* A set of drags has been added, we do not know at what cost; but we will allow a sufficient margin in computing the interest and depreciation. The engine is used for no other purpose than steam tillage, and is entirely confined to this farm; and (in consideration of the drags) let us put for interest at 5 per cent. 55*l.* per annum, and for depreciation (deducting rope and other wearing parts, on the principle adopted throughout our Report and elsewhere explained) say 45*l.* per annum. We have, then, for the whole yearly cost of the machinery (*i. e.* interest, depreciation, and all repairs and renewals) something like 240*l.*; which, divided over 1600 acres, comes to 3*s.* per acre—say 4*s.* per acre on ploughing or digging, and 2*s.* per acre on cultivating, &c.

Labour costs as follows:—The engine-man (a blacksmith at other times) has 3*s.* a day; the ploughman and anchorman 1*s.* 10*d.* each (*i. e.* 1*s.* a week over ordinary wages); besides which, the engineman and ploughman get a "perquisite" of 1½*d.* per acre each, and the anchorman 1*d.* per acre. There are also three boys at 1*s.* each, with a gratuity of ¼*d.* per acre. Half these additional payments when scarifying or dragging. One man and horse, with a water-barrel, can cart 100 to 120 gallons of water per hour; but occasionally the distance to the wells requires two water-carts, say 5*s.* per day. Removal takes a man and three horses, besides the steam-hands, occupying at the most two hours—say every third day, or say 8*d.* upon each working day. Coal costs 20*s.* a ton, and nearly this quantity is burned in a day, say 18*s.* worth. Of oil, two gallons last about nine days—say 1*s.* 3*d.* per day.

Mr. Edmonds gets out of his engine the following large amounts of performance:—On stiff land it ploughs or digs 8 acres a day; or 10 acres a day (or 1 acre per hour) on light soil, and with shallower work at 5 or 6 inches depth. And let it be

observed that this is an average daily rate, the engine often ploughing 60 acres in a week. The total cost for this (collecting and calculating out the above items, including cost of machinery) is 8*s.* to 8*s.* 10*d.* an acre. Of cultivation, the engine commonly does 18 acres per day, but varying from 15 up to 25 acres a day in spring work. The total cost for this is 3*s.* 8*d.* to 4*s.* 7*d.* per acre. The relative proportions of plough-work to cultivator-work we do not know; but if in about equal quantities, Mr. Edmonds' total yearly outlay upon steam tillage will come between 100*l.* and 200*l.* less than his former expenditure upon the 12 to 15 displaced horses.

Unlike nearly all other "steam" husbandmen, Mr. Edmonds does not break up whole ground with the scarifier; if he did, he would have to work both ways to make the operation thoroughly complete: so he prefers the plough or the digger. The scarifier he uses principally for crossing, and for the spring working of autumn-tilled land. He also finds very great benefit from the employment of Fowler's drag-harrows, that is, four heavy iron harrows, with straight teeth (for to-and-fro working), tilling 12 feet breadth, and slung beneath a steerage-frame carrying the rope slack-gear. But a lighter carriage-frame would be much better for the land. Mr. Edmonds manages to do what few steam-ploughmen effect, that is, 4-inch deep ploughing for wheat on particular fields that may require it. We walked over a piece of good land, exceedingly well ploughed 5 inches deep, after rye-grass; done too without the skim-coulters, which are troublesome, and therefore seldom used. It is customary here, as elsewhere, to roll down the furrow-slices of lea-ploughing and let them lie for a time before wheat-sowing. But after "steam"-ploughing, something more is required in order to get the requisite solidity; therefore the ploughing is done pretty early, and then, before sowing, the field is steam-dragged (*i. e.* heavy-harrowed) in the same direction as the furrows. If rolled at all, this is after the seed is in. On the strong land steam-digging early is the preparation for wheat, with a steam-harrowing before the drill. On the stone-brash, if on "whole-furrow" land (*i. e.* after seeds), the steam-ploughing is done deep in August, Mr. Edmonds no longer being afraid of deep work on such land for wheat.

The old high-backed ridges on the heavy land are being gradually flattened, care being taken not to level too quickly; and the land certainly dries sooner, the underdrains here being 3 feet deep. No material change has been made in the cropping of the farm beyond the occasional forcing in of an additional green crop, through being so forward with work. On the stiffer land there has been an increased yield of wheat and oats; but on the lighter soils no increase has been perceptible, unless the avoidance

of loss of plant may have swelled the average by making the crops more equable. The root-crops have been much improved by steam culture.

Mr. Edmonds' roots this year are certainly very good indeed; and the stubbles showed well, and particularly clean. We saw the engine at work; ploughing well, with the exception of making furrows of not perfectly equal size, the plough-irons (as we have noticed on several farms) not being well "set." Great care seems to be taken in the management of the machinery; the rope is properly dressed before being laid by for winter, and no difficulty at all is experienced in moving the engine wherever wanted.

Mr. Giles Edmonds, we believe, finding that this tackle has plenty of work upon its 1000 acres, is about starting an engine of his own; it having been expected at first that the present apparatus could manage the heaviest tillage of both farms.

Division 3.—South.

No. 43. Mr. John Walter, of Bearwood Park, Wokingham, Berkshire. Mr. Walter holds two farms in his own occupation—"Bearwood," near the beautiful demesne in which his new mansion is being built, and "Tangley Farm," a few miles distant, on the other side of Wokingham; both in an undulating country, thickly wooded with larch, growing furze and ferns too plentifully, and revealing in brooks and pits a superabundance of water. Steam cultivation is practised upon "Bearwood Farm," of 400 acres arable and 300 pasture, presenting a tolerably level surface, in fields of 20 up to 100 acres in area, but with fences not of the very best-grown quick. The land is chiefly a reclaimed heath (indeed, this is the character of the country for miles about); the soil variable—in some places light, with a gravel subsoil, in other parts loamy, with a clay subsoil, or a black "spewey" gravel, in which water rises up, prevented from sinking by a clay stratum underneath. Part requires underdrainage, and part drains naturally. A pair of horses can plough a furrow 8 inches deep, but, of course, dip the share less deeply for wheat. A team of 14 horses is kept; but as two of these are considered due to the estate-work, the normal force for the farm is really 12; whereas, without the steam-cultivator, 18 horses would be required, so that the engine has displaced 6. This, we should say, is the estimate of Mr. Henry Simmons, the manager; for in reality only the same number of horses was previously worked, but on a smaller farm, the acreage having been annually increased (so to speak, "from the wild"), and of course, at first starting, in a very rough condition.

The course of husbandry embraces about one-fifth roots, and

the chief benefits of the steam-work are found in the more effectual manner in which the tillages are done, in more successful crops of stubble-turnips, tares, and so on, and, most of all, in "much heavier" root-crops, which must have increased all the other crops too.

The steam-operations consist in grubbing up stubbles for roots, and cross-cultivating, for the horse-harrow to follow, with the hand-rake or basket after that, in cleansing land of couch. In spring the cultivator is employed in crossing the fallows, which are horse-ploughed for roots; no seed-bed (as a rule) being wholly prepared by steam. We did, however, see (the first week in November) a piece of good vetches coming up, which had been drilled after steam tillage. The swedes on Bearwood Farm are uncommonly good ("splendid," our note-book jotted them down); they were got in directly after horse-ploughing land that had been autumn-tilled by steam.

The tackle, consisting of a Clayton and Shuttleworth's 10-horse power double-cylinder portable, with a Howard's windlass, 3-furrow plough, 5-tined cultivator, side-harrow, and a set of harrows, was purchased in September, 1862, for 616*l.*; and the cost of additions, including a new rope in 1865, has been about 100*l.* The general repairs and overhauling the engine and tackle, in the autumn of 1865, cost about 35*l.* The engine thrashes the farm corn, and on only one occasion has the cultivating-tackle been let out for hire, when 30 acres in one field were cultivated twice over, at 10*s.* per acre, and "with a profit."

The first rope lasted three seasons; the present rope is scarcely worn at all. One windlass-pinion has been renewed, the other is nearly done for, and the india-rubber "universal joints" (now, we believe, abandoned by the makers for a more durable plan) want renewing. We observed that the compensating double-snatch-block was altogether out of order—in fact, wrongly put together by the men. The implement at work was the 3 and 5-tined cultivator; the rate of its performance is 8 to 10 acres a day. The plough is not much used: it required a man walking "at the head" to assist in steering, and never exceeded 5 acres per day. This points to some peculiarity in the state of the land at the time, or to the management of the tool; for, according to what we have witnessed elsewhere, swerving from its work is not a fault inherent in the implement itself. In this soil a single anchor to a snatch-block is found insufficient, and to prevent slipping or tearing through the loam and gravel, two anchors are set, one behind the other. Owing to this disadvantage, the Bulstrode-slings (see farms Nos. 51 and 102) cannot be (or, at least, are not) worked; though in other places we have seen the slings used easily enough with

duplicate anchors. The hands are ordinary farm-labourers: engineman at 3*s*., windlassman 2*s*. 6*d*., ploughman 2*s*. 4*d*., two anchormen 2*s*. 4*d*. each, and two porter-boys and a watercart-boy at 1*s*. 4*d*. each per day. Water is always found close at hand in ponds on the farm. Oil costs 1*s*. 2*d*. per day, and coal, at 21*s*. a ton, costs about 8*s*. a-day. "Shifting" takes place about twice a week, occupying 6 horses 4 to 6 hours each time.

We have said that 6 horses displaced, or 264*l*. a year saved in draft-labour, go to the credit of the engine. The manual-labour account of the farm has been increased rather than diminished; but the main results of steam culture (though not specially pointed in this case) are satisfactory from the decided augmentation of produce.

No. 44. Mr. James Williams, of Shippon, near Abingdon, Berkshire, a land-valuer and agent as well as farmer, occupies over 600 acres, chiefly arable; most of the land stone-brash, commonly thought unadapted for steam culture, seeing that its tillage is ordinary pair-horse ploughing at 5 inches deep. The system of husbandry is the 4-course, occasionally with barley after the last wheat-crop. In 1858 Mr. Williams purchased a 10-horse double-cylinder portable, with Howard's tackle, and has since added a Fowler 3-furrow plough. And this has enabled him to sell off 6 horses; the apparatus being also sent out on contract-work, besides every year tilling about one-third the area of his own farm. What is Mr. Williams' present force of teams we did not hear; but some extra horses are required for occasionally taking about the country several steam thrashing-machines, which he lets out.

The prices charged for steam-tillage work are 14*s*. an acre for grubbing once over, and 20*s*. for grubbing twice over, the farmer finding coal and water—the latter a light item, from the circumstance of water being obtainable anywhere in the locality at a few feet depth from the surface. Of course it would be hardly fair to detail all the several expenses involved in this work, because some neighbours might and would then say, Why do you charge us so much per acre, when actual cost to you is very considerably less? not making allowance for the distinction between a man's working for them and working for himself, for the differing risks of wear and tear under the two circumstances, and for the necessary laying by of a good annual sum with which to buy a new fire-box every now and then, pay for new parts necessitated by some unlooked-for accident, and ultimately replace a worn-out "set" by a new one.

But Mr. Williams speaks of comparatively few breakages, while the regular repairs have not been very heavy. The wear of

rope—the principal item in the damage to the machinery—he has found to be as nearly as possible 1*s*. per acre. The common rate of performance is 5 to 7 acres per day with the 3-tined cultivator, or 7 to 10 acres with the 5-tiner. In a very long day a much larger quantity has been got over. With the 3-furrow plough, 4 or 5 acres are turned over in a day; this having been shallow work for wheat-sowing.

Autumn breaking-up of stubbles answers admirably; but Mr. Williams attaches quite as much importance to ploughing in this season; in fact, he averred to us that one of the most valuable uses of the steam-tackle is in ploughing over wheat-stubbles, to lie through the winter and then to be cross-cultivated by steam in the spring for barley. He has obtained an increased yield of corn on a steam-cultivated seed-bed; he also now gets double the former weight of roots per acre, and necessarily, after more roots, he has more corn, and so on, through the rotation. But then this result is not all referable to the employment of a steam-horse; unquestionably the 300 fine Berkshire hogs that we saw fatting upon buckwheat (of which cheap imported feeding-grain and other corn 1000 quarters are annually consumed in these farm-premises), have something to do with the matter. Mr. Williams declared that he would never be without a steam cultivator on that or a like farm; and moreover told us that on a deep-loam farm, a former pupil of his has found "every inch deeper" equivalent to an artificial manuring—an acquisition likely to be experienced only for a time, though this may last through a considerable course of years.

(No. 45.) His Grace the Duke of Marlborough, Blenheim Palace, Oxfordshire, has employed a steam cultivator since October, 1861, upon stone-brash light and medium-loam land, having a subsoil of rubbly rock. The extent under occupation fluctuates according to what farms happen to be in His Grace's hands; the present area being 760 acres arable, besides 1590 acres of grass. The surface is tolerably level; and the inclosures vary from 35 to 40 acres. No new roads or other alterations have been made purposely to expedite field-work by the engine.

The apparatus consists of a Howard's 5-tined cultivator, with windlass, &c., driven by a 10-horse portable engine; which has broken up an average of about 9 acres per day, and over 1000 acres in each year; this amount of work occupying 130 days in each year, the days lost by bad weather being 9, and lost by breakages 3 days. This is a very concise statement, but valuable because of the scarcity of such accurate details; and it is very satisfactory that so great a breadth of work was got through with such a comparatively small amount of hindrance. Of course,

"when not steaming," the hands are employed in farm-work. The manual labour is that of 5 men and 3 boys; the engineer 3*s.*, the other men 2*s.*, and the boys 1*s.* each per day, or 14*s.* for the whole force. Ordinary labourers' wages are 10*s.*, and carters, 12*s.* per week. The carting of the 350 gallons of water boiled away costs 5*s.* per day; and a removal takes 8 horses and 4 men for 2 or 3 hours, which, done every fourth day, comes to about 2*s.* 3*d.* upon each day's work.* The engine has burned 8 cwts. of coal per day, at 15*s.* 6*d.* per ton, that is, 6*s.* 2*d.* a day, besides cartage, 2*s.* 6*d.* per ton; the oil has cost 1*s.*

What has been the wear and tear upon the large amount of work done by this apparatus? The repairs in the five years amount to 94*l.*, averaging on 130 days' work in each year 2*s.* 10½*d.* per day. Part of this sum is for new shares, and for repairing the axles and wheels of the cultivator; a quantity of exceedingly rough ground at first starting having worn these parts of the implement very much. The main item, however, was for a new rope; the first rope was worn out within the three years, and had cultivated about 2300 acres. Still, this rate of wear was much more rapid than it is now, because they did not work a sufficient number of porters at first to hold up the rope off this stony land. A "double-snatch-block" and extra porters were then procured, and have been found to save the rope a good deal, so that the present rope seems little the worse for two years' wear, and will certainly last over much more work than the other. According to this statement, furnished to us by the agent, Mr. James Napier, we may safely put the wear of rope at only 4*d.* to 6*d.* per acre for the sort of tillage done.†

"Interest" has to be computed upon the original cost price, 520*l.*, which with 21*l.* for the "additions," consisting of the double-snatch-block and rope-porters, makes the whole investment 541*l.* Probably we shall be near the mark, if (deducting wearing parts) we take "depreciation" upon 450*l.*; reckoning both this and the "interest" at 5 per cent. each, and charging the two amounts upon the 130 days' work in a year, and upon 9 acres per day.

The several items per day and per acre, averaged from totals of five years carefully booked, for more than 5000 acres of work done, will stand as follows:—

* That is the time actually employed, but with time spent in coming and going, the cost would be 3*s.* per day.—J. N.

† Some further allowance must be made for time lost by breakage or other mishaps, also for cleaning and dressing the rope-porters, &c., items which, though trivial in themselves, come to a considerable amount in the course of a year.—J. N.

	Per Day. £.	s.	d.	Per Acre. s.	d.
Manual labour	0	14	0	1	6½
Water-carting	0	5	0	0	6¼
Share of Removal	0	2	3	0	3
Coal	0	6	2	0	9
Oil	0	1	0	0	1¼
Working expenses	1	8	5	3	2
*Repairs	0	2	10½	0	3¾
Depreciation	0	3	5½	0	4½
Interest	0	4	1¾	0	5½
Total cost per day	1	18	10¾	4	3¾

The total annual outlay, for 130 days' work, will amount to 252*l.* 16*s.* 5*d.* But there is an error of excess in the calculation, arising from the whole of the depreciation and interest due upon the engine being charged to steam cultivation; whereas, this engine does all the thrashing of the farm, and the engine cost more than half of the purchase-money. A correction being made for this, would reduce the above totals probably 2*s.* per day, or nearly 3*d.* per acre, making the entire yearly cost of steam cultivation, say 240*l.*

Twenty-six horses were employed before "steam" was introduced, and 20 afterwards; and reckoning the 6 horses at 44*l.* per horse, the annual saving is 264*l.* That is, the outgoings for tillage remain about as they were; the Duke getting all the advantage of deeper and more expeditious cultivation without paying a penny extra for it.

The effect of steam culture upon "strong land under drainage" (one point included in our "instructions") may be here treated in the same way as "the snakes of Lapland;" the subject being foreign to the soil of Blenheim. The system of cropping has not been altered, nor has the acreage of root-crops been enlarged. The advantage, as far as regards increased production, is thus stated by Mr. Napier:—"the root crops have been considered better, by which other crops receive a corresponding benefit." Certainly, the Duke's swedes were the earliest, and, drilled wide and hoed-out wide, presented the biggest bulbs that we chanced to meet with in any English county. They had been "magnificently done;" but at the date when we walked through them (September 15th) we could not say whether they would not be beaten in quality by other rather backward swedes in the neighbourhood. The preparation for them was as follows: the land was steam "cultivated" and steam "crossed" in the autumn; then in spring it received one light cultivation, followed by harrowings and ridging in the usual way. The

* Includes wear and tear of rope at 4*d.* to 6*d.* per acre.

manure was 15 tons per acre of "farm-yard," and 2½ cwt. of "superphosphate."

No. 46. Mr. Miles Rodgett, of Sandford, Wareham, Dorsetshire, has reclaimed and broken-up to tillage, out of gorse and heather, between 400 and 500 acres of poor sandy and gravelly Heath, by a Howard 5-tined cultivator, and a set of "steam-harrows;" the engine being a double-cylinder 10-horse power. With half a ton of coal, at 20*s.* per ton, he cultivates 6 to 8 acres per day. His engine-driver has 15*s.*, ploughman 14*s.*, windlass-man 12*s.*, his anchor-men 12*s.* each, four porter-boys 6*s.* each per week. The engine is always set down where water is, and a boy to pump it costs 6*d.* a day. Removal occupies 4 horses for a day.

The whole tackle cost 500*l.*, in February, 1864; and a ridging-plough and 400 yards of extra rope were added for 35*l.* Repairs in two years and a half amounted to 10*l.* for "points" worn out and porters broken. Mr. Rodgett works with 2000 yards of rope in use at once, and in 1865 reported that it had gone over about 4000 acres, and that it was "showing signs of weakness." The cost price of the rope, we suppose, would be about 90*l.*, or 5¼*d.* per acre, a low rate attained by lightness of work and *four* porter-boys.

Division 4.—North.

No. 47. Mr. Peter Stevenson, of Rainton, Ripon, Yorkshire, occupies 390 acres of arable and 50 of pasture, including three sorts of land; about 60 acres being clay, while over the remainder of the farm, each field has several sorts of subsoil varying from strong loam to light sand, the geological basis being the new red sandstone. The heavy soil "3 and 4-horse land," is ploughed flat in this neighbourhood, and, when underdrained, dries very well; the lighter soil abounds with large boulders, which toss a steam-cultivator about "so that the men cannot ride," and occasionally the implement is tumbled upside down—a condition of ground and surface by no means favourable to steam-power husbandry.

Years before steam culture arrived in this part, Mr. Stevenson had adopted the smashing-up of stubbles by horse-drawn "Ducie drags." In the autumn of 1857 he purchased a 9-horse portable engine of Hornsby and Sons, with a set of Woolston tackle made by Humphries, and a 3-tined "Smith" cultivator made by Howard. This implement, 27 inches wide, was afterwards enlarged to 30 inches wide, by placing the two outer tines outside the beams, so as to take in effect 3 feet breadth of work at once. The engine cost 275*l.*; the tackle, &c., 205*l.*, or 480*l.* in all. The four-wheeled windlass has not cost 5*s.* in repairs; the

"turn-tables" (or snatch-blocks) have worn out about "a wheel" a-piece, and several rope-porters and an extra anchor have been added. But other repairs have been very trifling. The first rope, being of iron, was soon worn out; Mr. Stevenson observing that working on stony land, in a time of frosty nights and sunny days, wore away the metal "like wet iron on a grindstone." This destruction of 1400 yards of iron rope, and the very nearly wearing-out of a steel one of the same length, represent the consumption of rope during the nine years' employment of the apparatus; but in this last autumn (of 1866) the tackle was not worked at all, or not until nearly Christmas, owing to the wet season.

The farm lies tolerably level, and in fields of about 15 acres each, varying from 4 up to 27 acres; and the average rate of performance is about 5 acres cultivated per day. They never work in wet weather, and have never been stopped by breakages. The hands engaged are five men and two boys, at 13*s*. 6*d*. per day; and 6 to 8 cwts. of coal burned, costing 10*s*. to 12*s*. per ton. Where fields are contiguous, shifting is done by help of 2 or 3 horses, occupying 1½ to 2 hours, certainly more expeditious than we have found this business in many other cases. Mr. Stevenson sets his engine to thrash corn, cut chaff, and grind corn for horses and pigs. He keeps the same number of farm-horses as he did before adopting "steam," but then he has occupied 160 acres more land; the reduction on the old occupation would have been from 17 to 12, that is a saving of 5 horses. The steam-cultivator smashes up the stubbles in autumn for roots, breaks up stubbles for beans, breaks up part of the turnip-fold for barley, and also on the strong land bastard-fallows the 2-years' seeds in July in preparation for wheat. On strong land, Mr. Stevenson, in one year, cured a piece of its beds of thistles, by a single deep smashing-up; and on a piece of light sand with big boulder-stones, he has found no couch left after steam cultivating, and no increase of annuals.

There has been a small increase in the acreage of root-crops, because they are now grown on some heavy pieces where they could not be profitably attempted before. And the weight of roots per acre is decidedly greater, besides the advantage of the land being much more easily kept clear of couch-grass. Mr. Stevenson will not say that his corn crops yield more and better in consequence of steam cultivation; but he used to grow too much straw, and so now uses less guano, and gets a more regular and upstanding crop.

He has just bought a second-hand set of Howard's tackle, not so much from a wish to improve upon the old set, as because of

the cheapness of the lot offered, the whole having been "m with" for little more than the cost of a new steel rope, whic must have been procured for the old apparatus.

In many light-land and other districts, now popularly suppose to be unadapted for steam tillage, we have no doubt that th machinery only requires a practical introduction, in order to wi its way gradually in all directions. At least, this is the histor of the rise and progress of steam-ploughing in many localities analogous to that of the artificial manure trade in many quarte —a few years ago boasting that their fertile soil did not nee guano for corn-crops, or anything of the sort beyond "a littl something to pop up the turnips into rough leaf out of the wa of the fly," and yet gradually prevailed upon to experiment unti (to our knowledge) those same districts now find agents i uncommonly good commissions.

Still we are of opinion that really light lands, where larg quantity per day, rather than quality of work, is the great poin are waiting for wider implements, or perhaps for more than on implement in work at once. We have seen farms (for instanc Mr. Edmonds' and others) where 20 to 25 acres of cultivatin per day are done by a 14-horse engine; this is at the rate of 12 to 150 acres in a week. The double-engine system might accom plish much more; but before the engines can put out their ful power, they require implements taking a broader stripe at stroke. Why cannot an 8 or even a 10-feet wide cultivator b made to work—jointed longitudinally, if you please, like certain make of harrows, so as to keep close to an always wavin surface? If a 6-feet implement can now till 20 or 25 acres in day, a 10-feet implement might just as well compass 30 to 4 acres per day, 200 acres a week, in the great light-soil inclosure of some counties!

Obviously the double-engine arrangement alone can com into play for such wholesale seven-league-booted campaigning a this. The stationary-engine and windlass, shifted of necessit about once a day and losing a quarter of a day in the process would lose 6 or 7 acres every day, and be 30 to 40 acres behind hand at the end of a week, with no outlay saved to make th cost per acre as low as that of the expeditious double-engin work.

One great impediment to steam culture on light lands require notice. Large farmers find that, where reaping-machines ar employed, there is ample work in harvest for all the horse they now keep. Just at first there may be some to spare; bu when once carting has fully commenced, then, with the aid o one man and a boy, the reaper can be kept at work, and all th

horses are employed. In Norfolk about three horses are kept to every hundred acres of light land, and on stiffer soils and small farms four horses to each hundred acres. And what with carting corn, drag-raking, removing straw for stack bottoms and thatching, and carrying water, with most likely some horse-hoeing to be done as well, the light-land Norfolk farmer could not part with one-third of his horses, even if all the harvest were cut by hand, which is not at all desirable.

But if a costly steam apparatus is to bring its full benefit to these farmers, it should displace a portion of their horse-flesh. This could hardly be done except by steam undertaking a part of the carriage labour; and for anything we can tell it may some time be found practicable for the "double engines" to undertake a portion of the corn carting. Would it be practicable to manage this by setting the rows of shocks radially, pointing to one corner where the ricks are to stand; placing one engine in that corner, the other engine at the far end of each row of shocks in turn, and hauling by the wire ropes some broad low trucks, "empties" out, full ones coming "in," at the pace of five miles an hour? However, this at present is, of course, mere "theory."

Under existing circumstances, and when proper implements are brought out, probably the hiring system is best adapted for the light-land farmer, who has seldom enough tillage work to fully employ a powerful set of steam tackle.

For the sake of convenience to the reader, we bring under his eye, in a tabular form, a few items for comparison. (See next page.)

SECTION II.—HEAVY-LAND FARMS.

Division 1.—*East.*

No. 48. Mr. F. W. Bignell, of Loughton, Stony Stratford, Buckinghamshire, farms 222 acres, besides a considerable extent of old pasture; the soil and subsoil a tenacious calcareous clay, of a most unkind quality, usually ploughed in the district in 8-inch by 5-inch furrows by four horses, and fallowed without a crop. His first season with a Woolston set of tackle was in 1858, an 8-horse engine being hired of a steam-thrashing neighbour at 20*s.* per day, on the condition that Mr. Bignell should always have "first turn." This arrangement worked pretty well until last year, when the engine proprietor bought a set of cultivating tackle for himself, and Mr. Bignell had to get through one year as well as he could without steam-power—a new 10-horse single-cylinder engine having been now procured

Reference No. of the Farm.	Acres Arable.	Nature of Soil.	Apparatus.	Horse-power of Engine.	Acres Ploughed per Day.	Total Cost per Acre.	Acres Cultivated per Day.	Total Cost per Acre.	Total Yearly Cost of Steam Tillage.	Reduction in Number of Horses.	Number of Horses still kept for each 100 Acres.
34	300	Loam, upon clay and gravel	Smith	8	..	..	3, 5, to 8	9*s.* to 12*s.*	About £120	16 to 9	3
35	260	Loam, upon silt ..	Fowler's, separate windlass	12	7	..	..	..	..	14 to 10	4
36	650	Loam, upon clay ..	Smith	10	..	..	5	9*s.*	£178	24 to 18	$2\frac{3}{4}$
37	600	Two-thirds light, rest strong	Fowler's, separate windlass	12	7 to 10	..	10 to 20	..	..	18 to 12	2
38	About 600	Light, flinty, and strong loam ..	Smith	8	..	..	$6\frac{1}{2}$ to 10	..	..	No reduction	..
39	1200	Light sand and strong clay	Howard	10	..	..	5 to 8	..	..	40 to 34	Nearly 3
40	180	Light and heavy ..	Fowler's "round-about"	7	4	..	6	..	..	Saves 4	..
41	240	Sand	Howard	8	..	..	8	..	..	Saves 4 bullocks	$3\frac{1}{2}$
42	1000	Stonebrash, loam, and clay	Fowler..	14	8 to 10	8*s.* to 9*s.*	15 to 25	3*s.* 8*d.* to 4*s.* 7*d.*	..	35 to 20	2
43	400	Light and loam, gravel and clay ..	Howard	10	5	..	8 to 10	..	..	18 to 12	3
44	600	Stonebrash	Howard	10	..	..	5, 7, to 10	..	..	Saves 6	..
45	760	Stonebrash, light and loam	Howard	10	..	..	9	4*s.* 4*d.*	£253	26 to 20	$2\frac{2}{3}$
46	400 to 500	Sandy heath	Howard	10	..	..	6 to 8	..	..	..	..
47	390	Light sand, loam, and clay	Smith	9	..	..	5	..	..	17 to 12	3

for the present autumn work. The new system of tillage has banished the bare fallow altogether, enabling turnips and swedes, and a few mangolds to be grown. One piece of turnips that we saw is but a moderate crop; the swedes are exceedingly good, and remarkable for being the produce of such land. The fallow crops are clean, and only a few portions of foul ground appear on the farm. The rotation is (1) turnips, with vetches introduced in part; (2) barley; (3) seeds; (4) wheat; (5) barley or "pulse,"—that is beans, peas, or both mixed. The tillage consists in smashing up the stubbles in autumn, and then, after the ground has laid for some time, without any raking, picking, and burning of couch, trenching up into yard-wide drills and ridges by a 4-horse double-mouldboard plough before Christmas. In spring a 3-tined grubber, drawn by four horses, is taken through (that is lengthwise along) each ridge—tearing down, without mixing up the outer coating of winter-pulverized earth with the raw inside. The ground is then worked by harrowing, &c., and farm-yard manure ridged-in in the ordinary manner at sowing time.

The wheat stubble for barley or pulse is also broken up by the cultivator, and sometimes "crossed;" and while part of the clover lea is ploughed for wheat by horses, part is smashed up for wheat, with very good results if done early. We were shown one field of wheat, part upon ploughed, part upon cultivated land, the latter decidedly the better crop; but then the comparison is not fair, because here the clover had been mown twice, whereas the inferior produce is after clover mown once and then grazed; it being well known how the increased roots of clover that has twice sent up tall stalks and leaf will feed the succeeding corn. Occasionally Mr. Bignell has sown wheat broadcast, and then steam-tilled it in. Sheep eat off the turnips, swedes, and mangold, and their folds are smashed up for the barley seed-bed. Mr. Bignell does not approve the Woolston combined cultivator and drill for breaking-up and sowing at one operation. He is eloquent in favour of the Woolston cultivator, of keeping the weeds at top and killing them by a "crossing" after their first vegetation; and he denounces turn-over ploughing, except for a few special purposes. Being a bit of a mechanic in taste, he has attached a couple of tines behind the "No. 3" cultivator, so as to form at pleasure a 5-tine or 3-tine implement, and thus save the expense of having two separate frames, wheels, &c. The horse-cultivator we have mentioned, as tearing down the ridges in spring, is one of a pair that Mr. Bignell started when suddenly deprived of his engine. In form it is just like the Woolston 3-tiner, only smaller and lighter, 20 inches wide, so as to break up about two feet breadth at once. The peculiar

spud-shape of the shares, and their downward pointing, giving the greatest lift to the torn masses of earth, while the wheels in advance upon the unmoved ground bear the weight steadily and with the least friction, combine to make this "the best tool (says Mr. Bignell) ever invented for strong land." Obliged to put up with the absence of steam-power and the stronger grubber, he last year worked two of these implements, each drawn by four horses in length (so as to avoid treading down the broken-up clods), and working 7 inches deep at the rate of 2 acres a day. Horse cultivation like this was "only a little inferior" to steam cultivation. With an 8-horse engine a fair day's work has been 4½ to 5 acres with the 3-tined implement; in extra long days 7 acres have sometimes been accomplished. When the extra two tines are added, of course, much more is done. The fields are from 20 to 30 acres in extent, and well shaped for steam cultivation. Coals cost 14*s.* or 15*s.* per ton at the nearest station, four miles off, and the consumption has been 8 to 10 cwts. a day. Oil is put at 1*s.*, and water is carted by one horse, and a boy at 8*d.* a day. The apparatus is worked by six men and a boy—two men at 2*s.* 6*d.* each; four at 2*s.* each, and the lad at 10*d.* per day. Removal, varying a little according to distance, takes about two hours' time, with 4 horses, the water-cart horse, and a carter in addition to the steam-cultivating hands.

Mr. Bignell and his neighbour have done a good deal of work for hire—one finding tackle, the other the engine, and sharing the expenses and the proceeds. This has been upon several farms, the area varying every year, the average being perhaps from 1 to 200 acres. The rates charged have been 15*s.* an acre for "once over," and 25*s.* for "twice over." The men, when not cultivating, work at the ordinary labours of the farm. The steam tillage on Mr. Bignell's own farm occupies 14 to 16 days after harvest, and occasionally 3 or 4 in the spring; and this has been amply sufficient to enable him to dispense with 3 horses out of the 10 formerly kept, and yet be always forward with his work. Strictly speaking, 6 horses are now kept, with 2 colts bred on the farm and worked half-time alternately. The manual-labour bill, too, is not excessively heavy, amounting to less than 30*s.* an acre over the whole occupation—wages being commonly 12*s.* a week, in winter 11*s.* a week, and "Wolverton" (the railway works in the vicinity) making labourers very independent.

The apparatus cost 190*l.*, and a new rope since, 60*l.*; and the repairs (of which no account is given) are less heavy now than formerly, owing to the better management which has come into practice.

Among the general results, the drainage of this cold stiff clay

(which has not been well done in every part of the farm) is decidedly more effectual from the deep stirring of the steam-cultivator. The old high-backed lands are levelled, and yet water does not stand anywhere, even in the present wet time. On the greater productiveness of his cropping generally, Mr. Bignell says, "I speak somewhat diffidently in replying to this question, having introduced steam the second year of my occupation; but, as far as I can gather from others, no previous occupier ever obtained so much produce as myself. Judging from my first year, I think the advantage of steam culture has been very considerable."

No. 49. Mr. John S. Crawley, of Farley, Luton, Bedfordshire, works a set of Chandler and Oliver's tackle, substituted for Smith's—the peculiarity of the former consisting in the two winding-drums being hung upon the hind carriage-wheel axletree of the engine, one on each side of the boiler—the engine and windlass being thus combined. The cost of the 8-horse power engine, made by Robey and Co., with Smith's windlass, two cultivators, of 2 feet 4 inch and 5 feet 2 inch width respectively, was 590*l.** Mr. Crawley has kept no distinct account of the repairs. He pays his engine-driver 2*s.* 6*d.*; ploughmen, windlass-men, and two anchor-men, 1*s.* 10*d.* each; two porter-lads, 1*s.* 3*d.* each; and two boys 9*d.* each per day; with 1*s.* allowed for beer. Carting 600 gallons of water costs 4*s.*; oil 5½*d.* per day; and coal at 20*s.* a ton costs 8*s.* 3*d.* per day. As the engine helps to move itself, and there is no windlass, only two horses are required in shifting, and this takes a correspondingly shorter time than when a separate windlass has to be taken up, conveyed, and set down again in position; the interval occupied here being about 1½ hour.

On a strong clay soil, resting on a chalk subsoil, and in tolerably level fields averaging 30 acres each, now that trees and supernumerary fences have been stocked-up, the average performance is 5 acres per day with the small cultivator, or 7 acres with the larger one.

On a farm of 300 acres arable, with about as much grass, Mr. Crawley has diminished his former number of 16 horses down to 12. His remarks upon the "results" are, that the drainage acts better, and the land is more porous, though it does not admit of roots being fed-off in the winter. He has neither altered his old rotation nor enlarged his breadth of root-crop; but he says, "the crops generally are more productive and of better quality, attributable partly to draining, and partly to steam cultivation."

No. 50. Mr. John Horrell, of the Stevington Lodge Farm,

* We have abandoned the use of the axle windlass, as we found it too much for one man to attend to both engine and windlass.—T. T.

near Bedford, succeeded Mr. Pike (who here began steam cultivation in the year 1857), and purchased his apparatus second-hand in 1863. This consisted of a 10-horse-power double-cylinder engine, with Howard's tackle; the price not stated. After working it three seasons, his testimony is that he has worn out about half a rope, and that the cost of repairs altogether averages 40*l.* per annum. In the autumn of 1863 he broke up 38 acres for barley, 5 or 6 inches deep, by the 3-tined cultivator, in six days, including three shifts. A bean-stubble was smashed up for wheat, 5 or 6 inches deep, 13 acres twice over, making 26 acres in four days. An average day's work is 6 acres, and a removal takes 3 hours with 4 horses. In 1865, the summer tillage consisted of 100 acres, done in 20 days—that is, an average of 5 acres per day, removals included. The depth of work with the 30-inch wide cultivator was 7 to 8 inches; the autumn work was 127 acres in 25 days, at a depth of 4 to 5 inches. In both seasons a portion of the work was "crossing." Here we have 45 days' work and 227 acres done in a year on a farm which includes 307 acres arable (besides 150 of grass) of peculiarly stiff stubborn clay soil upon a subsoil of blue gault, some of it on steep hill-sides, and lying in fields averaging 30 acres in size—some of them enlarged purposely for steam culture. The engine is occupied in thrashing, grinding, and chaff-cutting 98 days in a year, or more than double the time that it is engaged in cultivation. The average consumption of coal per day in 1865 was 12 cwts., at 18*s.* per ton; of oil 3 pints,—say 12*s.* per day, or 2*s.* 5*d.* an acre for both. The wages of the 5 men and 2 boys come to about 13*s.* 6*d.* a day, and the water-cart 4*s.* a day—that is, 3*s.* 6*d.* per acre for both; ordinary labourers' wages being 11*s.* a week. Mr. Horrell gives his engine-man 1*s.*, his windlass-man 4*d.*, and his anchor-men 2*d.* a day extra (when steam cultivating), with a bonus of 6*d.* per acre for beer among all the hands. The daily working expenses, adding say 7*d.* per acre for removals, will be about 6*s.* 6*d.* per acre. What is the charge due on the machinery we have not sufficient data for ascertaining; though the 40*l.* for repairs is the most important item. The pecuniary experience of steam culture on this farm appears very similar to that of many others which we have more fully detailed.

The tackle is now used solely upon the farm; but has done contract-work at 21*s.* per acre, cultivating twice over, the farmer finding coal and water, and bringing the machinery home. Mr. Horrell does not consider this profitable, because of being set to desperately bad pieces. The engine is occasionally let out to thrash for other people, at a charge of 3*s.* per hour.

Good public roads run alongside much of the land, and a grass-

ride, 13 feet in width, runs through most of the fields which do not abut on these roads. The water-supply is in ponds in most of the fields. Mr. Horrell has not been tenant here sufficiently long to say much about changes and augmentations of cropping. The drainage, he says, is certainly rendered more effective by the steam tillage; but still the soil is too heavy for feeding off roots with sheep to advantage. Managing on the 4-course system, he keeps 10 horses, or 5 less than the farm employed prior to steam cultivation; and in general he "is very well satisfied with the apparatus."

No. 51. Messrs. James and Frederick Howard, Bedford. It is not necessary here to relate the history of Messrs. Howards' reclamation and remodelling of the Clapham Park and Green Farms, and their improvement of the Hoo Farm (all now classed together as "The Britannia Farms"), in the neighbourhood of Bedford. Clearing of forest-timber and underwood, abolition of old boundaries, throwing field to field and planting new fences, the formation of direct hard-mettle roads in place of winding clay lanes or across newly-opened country, the deep underdrainage of heavy soil, the laying down of new grass and cleansing of old tillage-land, have all been executed here with an expedition and completeness which may well stand out as an example of what should be done, and how it should be done, to prepare an estate for the full development of steam cultivation. Ten miles of hedge-rows have vanished before an army of workmen, all stubbing by the piece; and their removal has added just 10 acres to the area of Clapham Farm. Sound roadways enable the master-spirit of the tillage-work—the steam-engine—to perambulate where it will, uphill and down, in almost any weather, into any of the enclosures; and when there, though it is stationary with a windlass while working, it cultivates fields of 10, 20, 30, and up to 55½ acres "at one setting down." The drainage of almost every field has been designed with a view to supply the engine, a pond or open tank at almost every site occupied by the engine during the tillage of the whole estate receiving the drain-water, retaining supplies at all seasons, and letting only the "overflow" pass away by the mains which ultimately conduct it to the Ouse. At the principal farmstead a reservoir has been excavated, which contains half a million gallons, the cost of digging being 50*l.*

The extent of arable is 445 acres, all heavy land. The Hoo Farm presents a deep staple, 10 to 14 inches in thickness, upon homogeneous clay. Yet, before steam culture was practised, there were but a few inches of staple soil; the difference, on digging in a field and upon the headland edge, where the deep work has not

reached, being remarkable—the raw tenacious gaulty clay having been obviously changed by cultivation into a brown unctuous earth, at once perceptibly better to the feel. Although the old high-backed lands have been everywhere levelled over a 4-feet deep drainage, the whole of the fields are declared to drain well in the wettest of seasons; and we found nothing like sloppiness or sponginess, though we entered almost every field in wretchedly wet weather.

One set of tackle, of Messrs. Howards' own principle and manufacture, with a 10-horse-power double-cylinder engine, performs the heavy tillage labour of these farms, and is now limited to this work alone, not being let out on hire; while another portable engine is employed to do all the thrashing and other yard work. Thus the expenses of steam cultivation are not mixed up with those of any other operations; and the cost of repairs, &c., has been charged against the farms, on the same scale as they would be to a complete stranger, in order to make them a thorough test and example of the pecuniary as well as other aspects of the question. Mr. James Dickson, the farm-manager, has furnished us with the following "epitome" from his account books, giving the totals of three years' experience:—

	Acres.
The extent cultivated by steam has been	2751
Cultivated for neighbours	300
Harrowed by steam, 535 acres, equivalent to cultivating (half)	267
In three years	3318

The expenses for rope, repairs, and renewal of wearing parts have amounted to 99*l.* 15*s.* 5*d.*, or say 33*l.* per annum. Divided by the acreage, it comes to 7*d.* and a fraction per acre.

Interest, at 5 per cent. per annum on the cost price of 540*l.*, comes to 80*l.* 2*s.* in the three years, or a fraction under 6*d.* per acre.

Depreciation, at 5 per cent. per annum on the main portion of the engine and apparatus, but excluding rope and other wearing parts, say upon 440*l.*, amounts to 66*l.* in the three years, or a fraction over 4¾*d.* per acre. The three items of repairs, interest, and depreciation, make a total of about 1*s.* 6*d.* per acre.

We must remark here, however, that any heavy repair, such as a new fire-box next year, would materially increase this very low average, derived from an experience of three years.

To get at the total cost of any given operation, according to this statement, we have only to ascertain the daily working expenses and the number of acres done per day. Mr. Dickson gives them as follows:—

	£.	s.	d.
Engine-driver	0	2	8
Four labourers, at 2*s*. 3*d*.	0	9	0
Two porter-boys, at 10*d*.	0	1	8
One boy carrying water (no water-cart being used)	0	0	10
One day's manual labour	0	14	2
Coal (for 11 acres per day of 10 hours, a rate of work to be mentioned presently), 15 cwts. at 14*s*. per ton, with carriage, 2*s*. 6*d*.	0	13	0
Oil, one penny per acre on 11 acres	0	0	11
Repairs and renewal of rope and wearing parts, at 7*d*. per acre	0	6	5
Total working expenses per day	1	14	6
Or 3*s*. 1½*d*. per acre.			
Add—Interest, 6*d*. per acre	0	5	6
Depreciation, at 5*d*. per acre	0	4	7
Total outlay per day	2	4	7
Or a fraction over 4*s*. per acre.			

Mr. Dickson states that, on their very heavy clay soil, the cultivator taking 3 feet breadth and smashing up the land 6 to 8 inches deep, and travelling at the pace of 3 miles an hour, requires a pressure of 80 lbs. in the double-cylinder 10-horse power engine. There is "regularly on the move" by the cultivator from 6 to 8 cwts of soil, the shares cutting 3 feet of width, while it is 4 feet from the foremost point to the heel of the hindermost share—the weight of soil in a square yard, 6 inches deep, being 4 cwts. 3 qrs. 14 lbs. At this width, depth, and length, the rate of performance for a full day of 12 hours is 11 acres. The ordinary average of work, we were informed, was 6 to 8 acres a day (we suppose including removals), from 6 to as much as 10 inches deep—the steam working at a pressure of 50 to 70 lbs., with a consumption of 9 to 13 cwts. of coal. The manager's statement refers to their highest speed, with a greater pressure and more fuel burnt. In his figures, too, he has forgotten the cost of removals, which must be allowed for, if we would get at an average instead of a full day's work. The shifting, we were told, is done by help of 7 horses (4 horses, except for great distances), and takes 2½ hours. The engine, when uninterruptedly at work, has to be moved about twice a week; so that we may add say 2*s*. 5*d*. a day to the total daily outlay, making 2*l*. 7*s*. per day. Dividing this by the lower average of 8 acres per day, the total cost of a first smashing up (without including cross-cultivating or harrowing) is within a trifle of 6*s*. per acre. Undoubtedly, heavier repairs during the next three years will tend to raise these figures, which, as they are, certainly speak well in favour of steam culti-

vation. In fact, the cost is "a mere nothing" compared with the "value received;" the deep tillage of strong land is not accomplished by horses for as little as twice the cost here incurred by steam.

We saw the apparatus at work, deeply breaking up a stiff piece of bean stubble with excellent effect, though the rains had at that time (September 13th) hindered most people wherever we went from bringing out their steam-cultivators at all.* We need not describe Messrs. Howard's windlass, compensating double-snatch-blocks, two-way cultivator, rope-porters, anchors, &c.; but one feature in the apparatus struck our attention as a great improvement upon the old method of shifting the anchor-pulleys. This was the "Bulstrode" sling, by means of which the pulley, mounted on a boat-shaped block of wood, slides from one anchor to another, effecting a considerable economy of time. We observed that only 7 or 8 seconds elapsed between the implement stopping at the end and starting again. The headlands are 7 or 8 yards wide, and the practice is sometimes to finish off these by horse-labour, sometimes to break them up by steam before setting to work upon the surface of the field—the same plan is sometimes pursued with horse-grubbers not lifted out of the ground for turning.

Our remarks upon the farms in general were that everything seemed well done, and that the ground was very free from root-weeds and "vegetation:" the mangolds were particularly good and very clean. One splendid field of mangolds had been grown without farmyard manure, the artificial dressing being 5 cwts. of guano and 5 cwts. of salt. This was one of the few first-class crops we saw in all our journey. We must also compliment Messrs. Howard upon their magnificent swedes and turnips, upon rather kinder land than the majority of their property, though this particular piece has not been at present drained. One piece of yellow turnips, on newly-broken-up land, was patchy and defective; while a portion of the same field, which had been longer under cultivation, bore an exceedingly good crop of the same roots, put in at the same time and in the same way. The stubbles everywhere showed well—the heaviest wheat being after potatoes, and sown in a steam-cultivated seed-bed.

We have remarked in our tour how few employers of steam-apparatus adopt a new system of culture along with the new power. In many, or rather in most cases, the rotation of crops is altered; but in comparatively few instances (which will be found in the course of our Report) did we find anything like so great a change in the tillage operations themselves as prominent advo-

* This field has not been touched since, and, notwithstanding the wet season, it is now a nut-brown, mellow tilth, "like an ash-heap," ready to be drilled with barley after no other preparation than harrowing.—F. H.

cates of steam culture have recommended—or a revolution in husbandry like that exemplified with extraordinary success, though in a small way, at Woolston. Mr. Bignell's practice of grubbing and trenching, in place of ploughing (see farm No. 48), is one great deviation from the time-honoured track: here, on the Britannia Farms, we have it on a more important scale. Scarcely any horse turn-over ploughing is done; nor is the steam tillage limited to smashing up stubbles, or the turn-over ploughing of leas. And from the practice here we learn how mistaken is the view that a steam-cultivating tackle is to be used merely (or even mainly) as a supplementary assistant to the farm-team, and general forwarder of the heavy work of a farm. In fact, in the course of our journeys, we gradually came to classify (in our own minds) the users of steam-apparatus according as they looked upon it as an "auxiliary" to horses, or as "the slave of the farm;" and when we lighted upon a man using his engine only to clean stubbles in autumn, and occasionally to "cross" again in spring, upon such land as we had seen made into seed-beds for almost all crops by men of larger insight into the powers of steam, we called it a case of "steam culture made easy to small minds." How did Messrs. Howard prepare for their mangold crop? The wheat-stubble was not smashed up and then left for horse tillage in spring, but at once ridged by steam—the ridges 27 inches wide; this being done by a double-breasted plough-body fixed in the cultivator-frame, in place of the tines, while a subsoiling tine on the same implement rooted up the bottom of the open trenches, the ridging and subsoiling being accomplished in one operation. This lay all winter for the frosts and weather to make into the finest tilth imaginable; and in spring manure was applied, the ridges were torn down by a cross cultivation by steam, and the seed-bed was ready for the mangolds. Of course the ground must be clean to admit of cheap, quick tillage like this. Another field was done as follows:—The oat-stubble was forked over by hand to get out tufts of couch, farmyard-manure was applied, then the steam-cultivator smashed up the field, and, after lying some time, the rough fallow was ridged into 27-inch wide ridges (or "drills") by horses. In spring came a cross-cultivation by steam, the land was harrowed, and the mangold-seed drilled in. Messrs. Howard steam-grub their clover-leas for wheat, doing this in the summer, early enough for the land to get sufficiently firm at bottom before sowing time comes; finding that, when this point is attended to, the wheat-roots do not meet with the hollow bottom so difficult to be avoided except by first-rate and closely-tucked ploughing. In fact, this work being done in June and July makes a "bastard fallow."

No. 52. Mr. J. C. Robinson, of Stevington, near Bedford, occupies 400 acres arable, with 200 acres of pasture; part of the surface flat, some very hilly; the soil generally a very heavy clay indeed, and the subsoil gault or drift chalk-stone. The fields range in size from 5 to 42 acres, and have been slightly altered in figure to make way for steam culture; but the two or three smallest inclosures are still worked only by horses. A practical instance, this, of the necessity for providing fields with enough elbow-room in them for the new motive-power. Good road facilities already existed, so that no expense has been incurred in laying out new ones.

Mr. Robinson's experience extends over seven years. He worked a Smith's cultivator for three years, and then, seeing that his neighbour, Mr. Pike (he says), could "break up his land and form a good seed-bed by once going over" with a Howard cultivator, whilst he "was obliged to go twice over his land," he purchased the Bedford implement. The 8-horse engine cost 255*l.*, and the apparatus 250*l.*, everything included; that is, 505*l.* The repairs of the apparatus have been "a new rope, a few years back, costing 66*l.*, four or five snatch-blocks, and a few rope-porters,—say 100*l.* altogether." The repairs of the engine have been between 30*l.* and 40*l.*; but Mr. Robinson says that, as "the engine does more other work by far than cultivating," he "cannot put above one-third of cost of engine repairs to the cultivating." The number of acres cultivated in a year is not stated; but this proportionate division of these repairs is evidently justifiable when we know that the tackle is used solely upon this farm of 400 acres arable, while Mr. Robinson states that the engine is used to thrash the corn of 1000 acres in each year, and he also employs it about one day in a fortnight to grind corn and cut chaff. The "repairs," then, due to the steam cultivation of a 400-acre farm, during more than half-a-dozen years, have been about 112*l.*: to which we may probably add a few pounds for light repairs done by the blacksmith. The whole of the maintenance may have cost say 20*l.* a year; the interest upon the cost price of the apparatus 250*l.*, and upon one-third that of the engine 85*l.*, or 335*l.*, at 5 per cent. is 16*l.* 15*s.*; the depreciation, at the same rate upon the same sum minus the cost of the original rope and wearing parts, say upon 250*l.*, is 12*l.* 10*s.*; amounting altogether to 49*l.* 5*s.*, which is the whole yearly cost of the machinery for cultivating the 400-acre heavy-land farm. This in itself is a valuable piece of evidence, although we have not the data for making a calculation of the expense per day's work or per acre; because it tells the practical farmer of a similar occupation, that investing capital in such an apparatus will be little more serious than keeping an extra horse, with all the outgoings that belong

to him. Whether the actual working expenses make the steam-horse dear or profitable is very easily arrived at. Five men and two boys are employed, nearly always by the acre, getting 2*s.* to 3*s.* per acre, "and beer." Of coal, costing 18*s.* 6*d.* per ton, 7 cwts. per day is the common consumption; though 9 or 10 cwts. have been burned upon very hard work. As the acreage cultivated is 5 to 7 acres per day, "more when the weather is favourable," the coal costs on an average say 1*s.* 6*d.* an acre. Oil is probably a matter of 2*d.* an acre. The engine drinks four one-horse-loads of water per day; say at a cost of 6*d.* an acre. Removal every third day or so with the steam-hands and 8 or 9 horses, occupying two hours, if to an adjoining field—a much longer time if to a distance or if with fewer horses—will cost say about 2*s.* 6*d.* per day, or about 4*d.* per acre. The whole working expenses thus amount to about 5*s.* 9*d.* per acre. Can this be otherwise than wonderfully cheap; "very heavy clay, indeed," steam-cultivated for 5*s.* 9*d.* an acre, together with a yearly sum equivalent to little more than the expense that would be involved by an additional cart-horse? It cannot exceed what the cost of horse-power tillage would have been: probably it does not much exceed half, though, not knowing the annual acreage steam-cultivated, we cannot positively say. But while Mr. Robinson has obviously got into no heavy yearly outlay greater than he had before adopting steam culture, look at what he is realizing as actual saving and profit. The farm-team was 20 horses: seven years' experience warrants him in keeping only 14 now; and the banishment of six horses from the farm, with a saving of 44*l.* each, lessens the yearly outgoings by 264*l.* And this is a small item in the gain; for Mr. Robinson has been enabled by the steam-power to substitute beans and tares, or other green crops, for bare fallows; he has not increased the acreage of his roots, but "has them better;" while he "thinks the crops generally have been better," which he attributes to "more work being done in dry weather in early autumn." Of course, he gets this yield-bringing early work done, because 6 horses, that could turn over at most one acre and a half in a day, have quitted the field for a machine that rives up and shatters to pieces a deeper staple at the rate of four or five times that acreage in a day; or, in other words, which accomplishes the work not of 6, but of 24 to 30 horses. For the comparison should not be between horse-grubbing and steam-grubbing, but between horse-ploughing and steam-grubbing that is still more effectual.

On the subject of a resultant better drainage Mr. Robinson says, "I think clay-land should never be moved at all only when dry; but a farmer cannot afford to keep horses to do it while in

that state. If the top is moved dry, the air will go far into the subsoil, and where the dry air goes the water will follow, and very quickly be down to the drains: the drainage, therefore, must be rendered more effectual by the steam-cultivation." As to any extra facility for feeding off root-crops, he says, "clay-land worked in this dry state, with a good manure, would grow the best quality of roots; but I think the better you have got your tilth by cultivating, the deeper the sheep would tread into the land, and partly undo what you have done. I cart half off, that is, the biggest and best, eating the remainder on the land."

No. 53. Mr. William Lavender, of Biddenham, Bedford.—Conclusions drawn from eight years' experience under thoroughly business-like management are quite likely to command confidence, although unaccompanied by very elaborate statistics and calculations; and Mr. Lavender's testimony should have great weight, more particularly with that class of critics to whom figures "prove anything." He occupies 550 acres arable (besides old pasture), of which 300 acres are sound turnip-land, the rest clay and strong loam; some having a wet clay subsoil, and described as "always wet, that will not fly." Ordinary ploughing is done by 3-horse teams. A set of Smith's tackle was bought (we believe) in 1858; consisting of a double-cylinder 10-horse engine, made by Ruston and Procter of Lincoln, a 4-wheeled windlass, with "No. 3" and "No. 5" cultivators, and also a 7-tined grubber taking 6 feet breadth at once. This latter implement is precisely what is lacking in very many sets of apparatus; but it is essential, in order to get full duty out of the engine in light crossing operations or upon light land, whereas, in too many cases, the engine is seen "wasting her time in playing with a 3-tined fork." Mr. Lavender informed us that, with his wide implement, he was able to cross-cultivate 20 acres in a day; with the "5-tiner" he could manage 14 acres in "a long day." He has met with no particular breakages, except from once running into an anchor. This made the men more careful, because their pay is by the acre, and, when anything goes wrong, they "lose time." The repairs, or wear and tear, are declared by Mr. Lavender to be no greater than were incurred by farm-horses. We inspected the rope, and the wires appear now only about half worn through. Evidently by very careful management of the apparatus and a moderate share of work, a heavy expenditure has been avoided; and this result under piece-work is opposed to the experience of many other cases, in which day-work is insisted on as necessary for saving wear and tear, as well as preventing the tillage being scamped in depth. The practice here is to give the men 2*s.* 6*d.*, 2*s.*, or 1*s.* 6*d.* per acre, for working with the 3-tiner, 5-tiner, and 7-tiner respectively. They divide

the money between them as they please; generally the engine-man taking 6*d.* a day extra, and the windlass-man 2*d.* a day extra. For each removal 3*s.* are paid, the shift commonly occupying 2 or 3 hours with 8 horses.

Twenty horses were formerly kept. Some years ago the number was reduced to 14; but Mr. Lavender was obliged to increase them again up to 18, the present force, owing to the fields lying very much scattered about. The 4-course system of cropping is followed, and both a larger breadth of roots and heavier root-crops are grown in consequence of steam cultivation. No improvement is perceptible in the wheat-crops upon steam-cultivated land; but, of course, with more root-produce, there should be a derivative increase in corn. No example was adduced of steam *versus* horse tillage in the case of any individual crop. Mr. Lavender has never adopted the Woolston trenching-up for winter. As to drainage, he told us that the deeper culture decidedly makes a dryer layer for sheep. His verdict is that "all 3-horse land, if on a good-sized farm, should be steamed;" and if he were now without a steam-cultivator, he would certainly buy one to-morrow.

No. 54. Rev. J. W. C. Campion, of The Manor, Westoning, Woburn, Bedfordshire, occupying 500 acres arable, and the same area of grass—hilly land, consisting of stiff clay and strong loam—has worked a Howard set of tackle for four years. The 10-horse engine and apparatus were bought second-hand for about 500*l.*; the repairs are not stated, as they would form no guide to what might be looked for with new first-hand machinery. In Mr. Campion's fields, of about 30 acres each, the average day's work, including removals, is 7 to 8 acres cultivated. The five men and two boys cost 16*s.* a day; water-carting, 6*s.*; oil and grease, 2*s.*; coal, at 15*s.* per ton, including carriage, costs 15*s.* per day; and a removal, if done at once, takes 10 horses, which is accomplished and steam got up in four hours. The engine is employed "at other times" in thrashing, but the apparatus is never let out. The force of horses has been reduced from 22 before to 16 now.

Mr. Campion reports that the drainage has been rendered more effectual by the steam culture, but that he cannot feed-off roots any better than before. He has increased the acreage of his root-crop, and all his crops, "with the exception of the wheat crop," have been more productive.

Very few hindrances in work have been met with, and no stoppages when duplicates of the parts have been in possession.

No. 55. Mr. James Bartlett, of Whitfield, Brackley, Northamptonshire. The main object of our visit here was to learn the practical working of steam culture with Woolston implements,

and a peculiar form of windlass made by Mr. Edward Hayes, of the Watling Works, Stony Stratford. Mr. Hayes had informed us that his machinery has been in satisfactory operation upon large farms for more than seven years; among other places, on the farms of Mr. Charles Higgins, of Boycott Manor, near Buckingham, and Mr. William Hunt, of Shalstone, near Buckingham. The peculiarities of the windlass, and mode of working, may be thus described; there are three pulleys (or band-riggers) placed between the two coiling-rope drums, the action being stopped by shifting the engine-strap on to the middle or "dead" pulley, so that the engine is never stopped, and consequently there is no need for the complication of double-cylinders, and the attention required for engine-driving is reduced to a minimum. Then, no man is required at the windlass, for the stoppage is effected by means of a spring and trigger on the windlass, pulled by two cords which are laid along the field to the two anchor-men. When the implement arrives at the end, the anchor-man there instantly stops it by slightly checking the cord, and this action is so easy that sometimes even a horse setting his foot on the cord will suddenly arrest the progress of operations. The engine-driver has only to move a handle in order to start the other drums of the windlass; the braking of the slack-drum being effected by a self-acting steam-pressure cylinder and block. It appears, then, that Hayes' method does for the stationary-engine system (in one respect at least) what two engines do for the moving-engine system; it abolishes the risky work of signalling, so that the culture can be proceeded with in foggy weather, by dusky twilight, or even by moonlight, with perfect safety to the machinery. And if expedition be indeed the grand point of steam tillage, at certain times of the year this advantage is worth looking at, because relays of hands might be provided if necessary, while the steam-horse would not weary though never pulled up for 14 or 15 hours out of the 24.

Mr. Bartlett told us that his steam tackle was purchased in July, 1862; that on the first 100 acres cultivated the work cost 3s. 6*d*. an acre. The 57*l*. rope he considered to last over 2000 acres, which would amount to 6¾*d*. per acre. His blacksmith's bill, for small repairs, was 6*l*. 2*s*. 4*d*. in 1862; 17*l*. 4*s*. 4½*d*. in 1863 (including an alteration of the snatch-blocks); 2*l*. 10*s*. 9*d*. in 1864; and 3*l*. 7*s*. 3*d*. in 1865. Hayes' 100*l*. windlass has not cost a penny in repairs, and is now in good order. Mr. Bartlett gives his engine-man 3*s*. a day; the anchor-men 2*s*. each; ploughman 2*s*. per day; and two boys 1*s*. each, the wages of ordinary farm-labourers being 10*s*. a week. The rate of work is 5 acres a day with the 3-tined cultivator, and 8 acres with the 5-tiner. The soil is a stiff clay, taking 3 or 4 horses to plough a furrow 5

or 6 inches deep; the fields average 27 acres, and tolerably level. Removal takes 8 horses about 3 hours. The coal burnt is 10 cwts. a day, at 20*s.* per ton. The engine does the farm thrashing: if the cultivator is let out on hire the charge for cultivating and crossing is 20*s.* per acre.

Another form of windlass, presenting considerable advantages in stopping, starting, and braking, is made by Messrs. Tasker, of Andover. We regret that we were unable to see one, as we had intended, working for Mr. James Rawlence, of Bulbridge, Salisbury. We understand that several are in operation in that neighbourhood.

No. 56. Mr. Thomas Revis, of Olney, Buckinghamshire, occupies 800 acres arable, of loam clay and gravel, on a subsoil of clay and chalk stone; most part of the surface level, and fields squared and fences straightened, so that the inclosures vary from 20 to 60 acres each.

Seven years ago Mr. Revis purchased a 10-horse engine, made by Hayes, of Stony Stratford, for 300*l.*, and a Howard tackle for 170*l.*, making 470*l.* The implements used are a Bedford cultivator "when the land works kindly," and a Woolston cultivator "when very dry." The repairs, &c., have been—a new rope for 70*l.*; porters, &c., 10*l.*; and "a few incidentals." The working expenses are — for labour, 5 men at 2*s.* 3*d.* each; one man, 1*s.* 10*d.* (fetching water and oiling); and two boys at 10*d.* each. The water-cart, 3*s.*, fetches water from field-wells or ponds. Removal takes 6 horses for half a day "when it is on the same farm." Coal is burned at the rate of 10 to 12 cwts. per day, at 17*s.* a ton; oil may cost about 1*s.* The average work done is 6 to 7 acres cultivated in a day.

The apparatus is not let out, but occasionally lent to Mr. Revis's son, and to his tenants. In winter the engine drives a pair of 6 in. stones, grinding corn at the rate of 10 quarters in a day, and at the same time works a large chaff-engine, cutting 300 qrs. of chaff in a day.

Mr. Revis has not diminished his team force, as he has a good deal of carting to do—for building, repairs, &c., for his tenants —for which purposes he employs his own horses.

A great advantage is found in the improved drainage after steam culture. The 4-course rotation is followed—turnips being grown on the gravel and loam, and vetches, eaten off, upon the clay; but turnips are not attempted upon the very strong land.

Mr. Revis says, "I think that the crops are improved by steam cultivation. No person's look better than mine this season (1866); I fallow for barley after tares, and sow 3 cwts. of guano. When not dunged for tares, the land, after the barley, is farmyard-manured for beans; and for turnips, 12 loads of dung are

applied, with 2¼ cwts. of superphosphate." So that, if good crops are grown, steam should not have all the credit. He further says, "I use my apparatus more particularly after harvest, to cultivate 100 acres of bean land for wheat; if I kept it for no other purpose, I would not be without it; I could not have put in my wheat last year but for the steam-cultivator." *

No. 57. Mr. Jabez Turner, of Haddon Grange, Yaxley, Huntingdonshire. Experience of "second-hand" apparatus can hardly be given with fairness either to the manufacturers or to the subject of steam culture itself, because the real value of the machinery at starting is of necessity a very arbitrary and uncertain item, depending upon the management or mismanagement it may have undergone from the first purchaser. However, that even second-hand "sets" are not always fearfully expensive in the matter of repairs, does appear from numerous examples, among which we have the case of Mr. Turner. We did not visit his farm, but gather the following particulars from his answers to the Society's schedule of queries.

The occupation comprises 285 acres arable, and 145 of grass; 60 acres of the arable being very hilly. The soil is a strong clay, with limestone intermixed, having in parts a subsoil of very strong clay. The fields lie well for steam cultivation, averaging about 23 acres each; some alterations have been made by throwing the smallest inclosures together, but, with the exception of these cases, it has not been necessary to make new roads or alter headlands. In 1862 Mr. Turner bought a second-hand set of the Woolston tackle (manufactured by Howard of Bedford), together with a Fowler's small plough, and a second-hand 10-horse engine made by Horsfield of Leeds. The price of the engine was 150*l.*, to which must be added 15*l.* in repairing, making 165*l.* The second-hand tackle cost 155*l*; the plough, 65*l.*; and a length of new rope, 25*l.*; altogether 245*l.*, or a total of 405*l.* for the whole. On first commencing, the hindrances were frequent from breakages, but as all the land has now been subjected to the plough or cultivator, and is becoming more level, the stoppages now are very few, excepting the delays from unsuitable weather. The ordinary wear and tear is stated by Mr. Turner at 12*l.* per annum, and, adding 5 per cent. interest upon the prime outlay, and 5 per cent. upon somewhat less than the whole outlay, for depreciation, say 36*l.*, the yearly cost of the machinery will be 48*l.* The number of days' work in each year has not been taken account of, but during 1865 the engine was at work on the farm for 91½ days; perhaps

* In the wet autumn of 1866 I sowed my wheat broad cast, cultivated it with Howard's implement harrows, picked it afterwards, and the wheat comes well.—T. R.

we may put the cost of the machinery at 10*s.* a day's work. The engine does all the thrashing, corn-grinding, and chaff-cutting at home, but no work off the farm. The daily working expenses in the field are as follows—half a ton of coal, in a day of 10 hours, costs 7*s.* 6*d.*, and oil 1*s.* A boy with the water-cart leads water from a brook or from ponds; though in several fields it is practicable to place the engine close to the water—say 4*s.* for this item. The engineer has 3*s.* 6*d.*, and the windlass-man, two anchor-men, ploughman, and porter-man, 2*s.* each, making 13*s.* 6*d.* When not cultivating, they are employed at ordinary farm-work. Removal, for a moderately short distance, occupies 4 men and 8 horses for about 4 hours, and allowing for a shift every fourth day, the cost would be about 3*s.* upon each day's work. The working expenses are thus about 29*s.* per day; the total, with cost of apparatus, about 39*s.* per day. When a full day's work is done, and no "stoppages" occur, 4 acres are ploughed or "dug," or 7 acres cultivated. This is a low rate of performance, making the tillage correspondingly dear; that is, 5*s.* 7*d.* an acre for cultivating, up to nearly 10*s.* per acre for ploughing. Nevertheless, on Mr. Turner's heavy soil the advantages of steam-power husbandry are great enough to tell in favour even of work far from being so expeditious and cheaply executed as we find it in many other cases. For, instead of 14 horses, only 9 are now kept; and the annual saving in the keep, maintenance, attendance, tradesmen's bills, implements, &c., for 5 horses, taken at 44*l.* per horse, must amount to more than the whole yearly outlay upon steam tillage. Whether or not it could be done at a cheaper rate, it costs altogether no more than the horse-work which it has superseded.

As to actual benefits, Mr. Turner has increased the acreage of his root-crops, growing and feeding-off roots where previously the system had been to dead-fallow every fourth year. His crops generally are also more productive; though this is not entirely due to the mechanical tillage, seeing that much artificial food and manure have been used for years, doubtless with fertilizing effect.

The drainage of this heavy land is "certainly more effectual," while, "in an ordinary dry season," says Mr. Turner, "root crops can now be *eaten off* where, without steam, they could not be *grown*."

No. 58. Mr. Owen Wallis, of Overstone Grange, Northampton. Mr. Wallis—occupying a home farm of 375 acres arable, with 28 of pasture, and also a large grazing farm at a distance—has had five years' experience of steam cultivation. The soil of the largest part of the farm is a clay-loam, with a subsoil of calcareous clay—a drift-clay, containing flint and

other pebbles and small fragments of chalk; four large fields are of stiff clay; some of the land has clay-and-sand veins, which are noted for being "either all bricks or all mortar;" and a portion of the farm is of a lighter description, adapted for turnip as well as bean growing. There is very little stone to interfere with the progress of the implements or to grind the rope. The surface presents gentle slopes, without being steep or hilly in more than two or three fields, and the enclosures are large, having been squared and fences straightened some time before steam-ploughing was adopted. In some fields an exchange of property has enabled a straight fence to be struck, in place of a most crooked boundary; and old parish bounds and the sites of grubbed-up hedges are seen across several of Mr. Wallis's fields by the big timber-trees still left standing in line in the middle of green crops and stubbles. Were it not for these remnants of "the forest primeval," this farm would be splendidly laid out for steam tillage; as it is, we know from experience in similar situations, that many plough-skifes must be broken in the course of a year against the huge roots of these field-trees; and the necessity for going at a snail's pace when under their shadow, and shifting the ropes twice at each tree, must lose the engine and men a great deal of precious time. We observed, too, that while Mr. Wallis sides up his thorn-fences to perfection (topping, however, only in the winter, so as not to weaken the growth by cutting away too much green) many of the fences are over-crowded with timber—a state of things eminently mischievous, we should say, to the tenant, and of no earthly advantage to the proprietor, seeing that the trees are damaging one another, and the felling of one-half would both enhance the picturesque effect and promote the growth into profit of the remainder. Perhaps we may be permitted to name here the example of Lord Leicester, whose practice is to sell injurious hedge-row or outstanding timber to his tenants at below market-price, with an order for immediate cutting-down.

At the Leeds meeting, in 1861, Mr. Wallis purchased a Fowler 14-horse engine, cultivator, and plough, with drag-harrow to work at the side; and added a "rope-carrier," or light 4-wheeled carriage, with reel upon it, made by Amies and Barford, of Peterborough, which he finds very handy in removals, and for taking care of the most costly wearing-part of the tackle. Elaborate book-keeping has not been pursued with respect to the steam tillage, so that we can record only the experience and results as they appear in the long run. The engine is used entirely in field-work, an old portable doing duty with the thrashing-machine, &c., and no steam-culture has been undertaken off this one farm. The "road-gear" of the engine has stood well; no difficulty or special delay has arisen with the anchorage, the implements, or "slack-gear;" and only

a very few new "clips" have been required on the drum. Between 300 and 400 acres have been grubbed or ploughed each year, say nearly 2000 acres in the five years, and the renewal of rope has amounted to only 650 yards; the remaining portion of old rope is still working, and the 650 yards of new is, in our judgment, about one-fourth worn. The consumption of rope due to the 2000 acres' work would appear to be about 900 yards' length, or say about 1*s.* per acre. The daily performance is 6 acres with the digger or the plough, and 12 acres with the cultivator, the coal burned being 15 cwts. per day, at 15*s.* per ton. The water is carted from a brook, or from the homestead, as most convenient.

To shift the whole machinery from one field to another generally occupies 4 horses and the steam-hands for three hours.

On the principal part of the farm a 5-course rotation of cropping is adopted, that is to say, (1) turnips, (2) wheat, (3) barley, (4) seeds, (5) wheat; or else (1) turnips, (2) oats, (3) wheat or barley, (4) seeds, (5) wheat. The steam-work embraces "smashing up" all the wheat-stubble for the fallow-crop or for the barley—the preparation for roots consisting of "three times over" with the cultivator or the plough, while the seed-bed for barley is worked twice. When clean, the land is broken up by the "digger;" when any twitch has to be eradicated, the cultivator is the first tool employed. Then, further, a portion of the seeds (layer or aftermath) is ploughed by the engine for wheat; the remainder being ploughed, as usual, by horses. And Mr. Wallis makes admirable steam-ploughing with the shallow furrow slices requisite for a wheat seed-bed by driving five 8-inch wide instead of four 10-inch wide furrows—thus obtaining the right proportional dimensions for neatly turning work only 5 inches in depth; and the drag-harrow hung beside the plough reduces to tilth, without the trampling of horses' hoofs. By a judicious application of steam-power husbandry, the fallow-break, at first starting, was cultivated only 6 or 7 inches deep; whereas now, the digger is put in 9 or 10 inches; and this cautious and sensible method of procedure has undoubtedly avoided many of the disappointments which have overtaken some adventurous steam-ploughmen before they began to realise the wondrous profits they had expected.

Mr. Wallis's turnip-crops are certainly very fine, and his practice is to feed off about three-fourths—the other quarter being carted to the homestead. One field of rape was shown us, part of which had been steam-tilled and the other horse-ploughed: the plant was small and somewhat "foxy" on the latter part, but very thick, high, and luxuriant on the "steamed" portion of the land. We had the pleasure of walking over "a good farm, well dône;" the stubbles being strong and the whole farm remark-

ably clean, excepting only one "close," a little grassy, and this is a wheat-stubble, the seed-bed for the wheat having been ploughed 5 inches deep by steam-power, after one year's rye-grass. On the four fields of clay soil green crops have been a gain entirely due to steam cultivation—taking the place of bare fallow in a 4-course rotation, which brings beans and clover every eighth year. Mr. Wallis has not greatly reduced his stock of farm-horses, the 14 he used to work being now lessened by 2 or 3.

The drainage of the farm was formerly accomplished by bundles of wood tied up and buried some 18 inches deep, and this sort of work stood (in some places) for 25 years. All is now well drained with pipes at an average depth of 4 feet, that is, varying from 3½ to 4½ feet; the old broad high ridges have been gradually lowered, and now "the water sinks away better" after the steam-work than after horse-ploughing.

No. 59. Mr. John White Pell, of Manor Farm, Stanion, Thrapston, Northamptonshire, occupies 500 acres of arable and 225 acres of pasture, principally a strong clay soil upon a subsoil of limestone and clay. The surface is generally level, in fields of about 20 acres each, a little altered to suit steam cultivation. His apparatus, consisting of a 10-horse portable engine, by Bultin, of Northampton, and a set of Howard's tackle, with a 3-tined and a 5-tined cultivator, cost 470*l.* in the year 1861; the "additions" since have been one new rope, at 60*l.*, and the repairs very light, Mr. Pell having met with "no bad accidents" so as to require anything more than ordinary replacement of wearing parts. The machinery is worked about 55 days in a year, a small part of its time being spent upon three neighbouring farms, doing a few days' contract work. This has amounted to only 30 acres worked twice over (that is, 60 acres of grubbing altogether), at a charge of 22*s.* per acre. The engine is used for thrashing, grinding, cutting chaff, and pulping roots.

The hands required are 5 men and 3 boys, at 15*s.* per day; and these, when not cultivating, are employed at ordinary work upon the farm. The water is supplied by a water-cart and one horse; the oil costs 1*s.* and the coal (at 16*s.* per ton) costs 12*s.* per day. Moving the tackle and setting down to work again is accomplished in 2½ hours, by the aid of 9 horses and 5 men. The average work done per day amounts to 7 acres of deep grubbing. Having been unable to visit Mr. Pell and make our own inquiries, we can form only a very rough estimate of the outlay and return in his case. Fifty-five days' working expenses (including removals) appear to be something like 116*l.* a year; interest and depreciation, at 10 per cent. on the whole prime cost, 470*l.*, would be 47*l.* The engine (which cost 270*l.* out of the whole 470*l.*) does so much other work, that we shall not favour

the steam culture if we set off this work against the "repairs," which are not stated; and we have thus a total expenditure of about 163*l.*

Mr. Pell formerly kept 18 horses. The steam-engine has displaced four of them, and therefore the saving, valued at 44*l.* per horse (for which refer to the opening of this Report), just about meets the outlay incurred by the steam-cultivator.

The gain consists in a better drainage of the heavy staple consequent upon breaking up the panny subsoil, in a considerably increased acreage of root-crop, and a better grown and larger root-produce per acre; though Mr. Pell has not found any greater facility than before in feeding-off by sheep. More roots have necessarily brought more stock and more manure, resulting in a larger yield of corn. In fact, Mr. Pell is of opinion that, by the introduction of steam tillage, his grain-crops have become more productive to the extent of 6 bushels per acre more than they were before. Such handsome results having accrued, it matters very little whether or not the steam tillage costs a few pounds more than the old horse tillage which it has displaced.

No. 60. Mr. John Walker Watts, of Orlingbury, Wellingborough, Northamptonshire. Leaving the Nene valley at Wellingborough, and passing through an undulating district of rich pastures, with clay-banks or oolite stone in the road-side cuttings, and with brick-and-tile yards on either hand, we found the pretty village of Orlingbury. Here resides A. A. Young, Esq., who, having had a Fowler steam-plough in partnership with Mr. Watts, has now given up both land and implement into the hands of the latter gentleman. Mr. Watts occupies 570 acres arable and 400 acres grass—the soil for the most part an exceedingly strong poor clay, upon a tenacious clay subsoil, but with occasional patches of red land of a much kinder and more productive quality. The surface is hilly, presenting many rather steep inclines, the elevations in many of the fields preventing portions of one headland from being seen from the headland opposite, thus rendering needful very smart practice with the steam-plough signals. Considerable clearances have been made of bushy hedge-rows, the inclosures now averaging about 30 acres each; and though no new roads have been formed, the headlands have been straightened to facilitate operations with the engine and travelling anchorage. One field of 65 acres has been shaped out of six inclosures, of which the fences have been "stubbed up;" and though still of a long and most irregular figure, in spite of the give-and-take straightening of a water-course, the principal part of the area is tilled from two straight engine ways, while small angles are left to be finished up by horses.

The tackle was purchased in October, 1861, consisting of a

14-horse Fowler engine and anchorage, &c., with a 4-furrow plough and a 7-tined cultivator, the cost being 945*l.* The cultivator is more worked than the turnover-plough, the principal employment of the engine being to smash up stubbles in autumn and cross them in preparation for green crops or fallow. When the land is clean, the plough with the digging-breasts on is the best tool for this autumn work, to be followed by the cultivator crosswise in spring. With steam usually at 80 lbs. pressure, and with a consumption of 10 to 12 cwts. of coal per day, the work done is 5 or 6 acres of ploughing or digging, or 8 up to 11 acres of grubbing with the balance-cultivator. The labour includes the engineman at 3*s.* per day, ploughman 2*s.* (the common wage of the district), anchorman 2*s.*, and two boys at 1*s.* each; added to which is a bonus of 6*d.* per acre, divided among all the hands. These men are at ordinary farmwork when the engine is not going. The water is carried from near the homestead at a cost of about 3*s.* 6*d.* a day, that is, by one horse and a lad paid 1*s.* per day—the work being light because the water-cart is fitted with a pump and hose. The cost of oil is about 1*s.* 6*d.* a day, and the coal (costing 12*s.* 6*d.* a-ton at a station 3 miles off) may be reckoned at 8*s.* 6*d.* per day. Removal is effected by the water-cart horse, another extra horse, and the men and boys engaged with the tackle, in about four hours—the engine being self-travelling, with a man to steer. If four horses are employed the shift can be done in three hours. The repairs have cost on an average about 45*l.* per annum for plough and cultivator shares, porter-wheels and pulleys, and repairs to the engine (which we shall presently explain), and to the anchorage, plough, and cultivator; besides about 20*l.* a year for wire-rope.

Mr. Watts does not make a practice of letting out the apparatus, but has worked for a few friends: in July or August, for instance, he cultivated 72 acres once over, and at a depth of 9 inches, for the contract price of 13*s.* 4*d.* per acre, the farmer finding coal and water, and sending the machinery home. A detailed statement of the acreage done during the five years is not forthcoming, Mr. Watts having tired of keeping elaborate statistics without practical benefit to himself; but the following is the account for 1866 from April to harvest, representing a half-year's operations. The apparatus was engaged for 5 days in April, 16¾ days in May, 6½ days in June, 17 days in July, and 9¾ days in August,—in all 55 days; during which time 13 acres were ploughed, and 374 acres were cultivated, the machinery having travelled also 48 miles. The outlay for labour was 31*l.* 14*s.*; this includes, however, only a portion of the water-carting, as a considerable share of the tillage was contract-work. The coals burnt were 33 tons, at 14*s.* 6*d.*, amounting to 23*l.* 18*s.*,

and the expense of oil was about 4*l.* 3*s.* The smiths' bills came to 4*l.* 2*s.*, and the Leeds invoices for points, wheels, &c., amounted to 7*l.* The wear of rope Mr. Watts has found to average about 25 per cent. per annum upon its prime cost, 84*l.*; say for half a year, 10*l.* 10*s.* Interest and depreciation are wholly chargeable upon the steam tillage, because, having a small portable engine for thrashing, &c., the 14-horse engine is seldom, if ever, set to anything but its legitimate employment. On 945*l.*, a charge of 5 per cent. interest per annum for half a year is 23*l.* 12*s.* 6*d.* Depreciation, at the same rate, upon say 800*l.* (a portion of the apparatus) is 20*l.* And summing up all these items of expenditure, we have a total of 125*l.*, being at the rate of 2*l.* 5*s.* 6*d.* per day; or 387 acres were steam-cultivated at a cost of 6*s.* 6*d.* per acre. With the addition of water-carting in the contract-work, and a slight increase in the item of repairs, which in a course of years have been at double the rate due upon that particular half-year, the extreme cost would probably be a few pence above 7*s.* per acre; and this is for deeply and thoroughly breaking up, at an average of 7 acres a day, land on which four horses are needed to plough three roods a day 5 inches deep. This is an extraordinary, but soundly-made, estimate of results,—steam-power at 7*s.*, against horse-power at 16*s.* per acre.

Mr. Watts having latterly kept no statistics of the acreage or the number of days' work in each year, we cannot say what his annual expenses and performances actually are; but, taking the above half-year's statement to represent (which Mr. Watts thinks it does) about half the work of a year, the annual totals will be between 700 and 800 acres tilled at an expense of about 300*l.* A considerable proportion of this work (but the precise quantity not given) is done at a profit, for a certain price agreed upon; and that the remainder, executed upon Mr. Watts' own farm, is more than paid for by his saving of horse-flesh, is very evident from the following estimate. The farm having been enlarged at the time when steam culture was adopted, the number of horses formerly kept will not serve for comparison: the proportion of horses due to the present extent of arable, according to the usual practice of the district, is 20 or 22; and, allowing for certain estate-work done for the squire, the present force is 13 or 14 horses. Seven or eight horses saved, at 44*l.* a year each (the figure adopted throughout this Report), more than cover the whole sum yearly expended in steam cultivation; and then, by a considerable share of the work thus paid for, Mr. Watts earns a good price per acre from his neighbours.

The effects upon the farm may be thus epitomized:—Broad lands—common to the district, but not thrown up very high—

have been gradually reduced to the flat, without injury to cropping, and without materially affecting the drainage excepting that this is now "more effectual." The land is all pipe-drained, and water does not stand on the surface after the heaviest rains—though this drenching season has shown it in one spot on the farm. It should be named that the average annual rainfall of this locality is the moderate one of about 25 inches. Although the drainage may be said to have improved, rather than the contrary, Mr. Watts finds that the deeper staple makes a worse lair for feeding off green and root crops by sheep.

The ability to work this strong land at the best time—that is in dry weather and in autumn—has given a generally-increased yield to the crops; though 6 or 7-inch deep ploughing has been found to be 2 or 3 inches too deep for wheat-seeding, and loss of yield has been experienced where it was practised. A still greater gain than the augmented produce per acre has been a larger acreage of cropping grown. Not a greater breadth of roots; because Mr. Watts does not get his best grain-crops after them: but he has more corn and less fallow,—the usual 4-course system of the neighbourhood being modified to a 5-course by taking two white-straw crops together.

We made inquiries as to the special nature of the repairs, breakages, &c. Mr. Watts reports that the clipping-pieces on the drum have held good through all the work; he has replaced some of them, but has had nothing like a complete new set; and there is no excessive grinding or damaging of the rope by their action even in the hardest pulling. Many of the small stoppages which arise in the course of a day, he attributes to occasional troubles with the slack-gear on the implement, from inattention in keeping the pitch-chains tight, from dirt or pebbles getting into the ratchets, the spiral springs, or the bearings; and so on.* Would it be advisable to box-in this portion of the apparatus? No objection whatever has been found against so heavy a motor as a 14-horse self-travelling engine in this hilly clay-district; the employer being careful not to take it out when the weather is utterly unsuitable. Indeed, Mr. Watts is so satisfied on this point, that he has procured another engine, and is altering the present one for working on the double-engine system.

Two items of expense in the case of this tackle—one arising from a faulty principle of construction now abandoned by the maker, and another from ignorance or mismanagement on the part of the men at starting—it would be unfair to charge as part of the regular cost of steam cultivation. Mr. Watts' "breakages"

* The double engine will remove all difficulty about slack rope-gear.—T. W. W.

consist in having strained the "slanting shaft" belonging to the "road-gear" on the engine; and this twice over. But a much stronger shaft being since put in its place, the engine travels up or down hill, over jolty or deep soft roads, without any difficulty or casualty. The other accident occurred to a 450-yards' length of rope, from the men improperly unwinding the new coil. This should have been done (as all steam-plough men are aware) by laying a cart-wheel down upon the ground, fixing a stake upright through the hob, laying the coil of rope on the wheel, and then another cart-wheel over the coil, inclosing it like cotton between the two flanges of a reel, the whole running round like a swivel when the rope is led off. By ignorantly "undoing" the new coil without thus holding it down, and by attempting to unwind it without making it rotate, the men necessarily gave it a twist for each coil taken off; the rope flew into curls, got "kanked," and consequently at each "kank" the wires were injured, and soon wore through in crossing over the rollers of the rope-porters. Of course spoiling a rope in this way ought not to be heard of among steam-ploughing risks and casualties.

No. 61. Mr. F. Eddison, of North Laiths, Ollerton, Nottinghamshire, has a Fowler "double-set," consisting of two 10-horse engines, with winding-drums, working a 4-furrow plough, 7-tined cultivator, and harrow. The purchase was made only in March, 1866. The farm is partly of red clay, and partly of strong soil, with stony gravel bottom; 306 acres arable, with 108 acres grass; half the surface hilly, and in fields averaging 15 acres apiece. The cultivator does about 16 or 17 acres in a day of 10 hours; the coals burned being 5 or 6 cwts. by each engine, or 10 to 12 cwts. per day, at 15*s.* per ton. Water is fetched by horse and cart from a stream. The hands include three men and two boys; wages, 20*s.*, 18*s.*, 15*s.*, 10*s.*, and 6*s.* each per week. In removal, of course, the engines are independent of assistance; and one is moving, and the other ready to move, as the last bout is finished. The apparatus worked on ... other farms, within the first spring and summer, cultivating ... 200 acres, at 8*s.* 6*d.* to 12*s.* an acre—the farmers finding ... porter-boys, and board and lodging for the men. The ... force of 16 horses is reduced to 8 now.

No. 62. Mr Henry Hemsley, of Harlaxton, near Grantham, Lincolnshire, occupies 332 acres of arable (besides 154 acres of pasture), ... acres being a white heavy clay, and 218 acres a ... or oolite soil, upon blue lias. The clay part is ... about 14 acres each; the turnip-land in 30-acre ... having been enlarged, and many old crooked fences ... and others planted straight, for facilitating steam culti... [illegible] ... thus saving (on our

estimate) 176*l.* a year. The drainage has been much improved by steam cultivation, the clay dries sooner; and Mr. Hemsley is quite satisfied with having the surface flat, that is, without ridge and furrow; however, most of the fields have a good natural slope. He has no dead-fallow now; getting tares and other sheep-feed (but not attempting root-crops on the clay), and occasionally a second white crop is taken; which was not allowed under the old system. On the turnip-land he now gets two white corn-crops after the roots, then seeds eaten with cake, next wheat, and lastly, barley; a very heavy course, requiring a great deal of cake and artificial manure to keep the soil in condition. He does not report any special augmentation in the produce of roots, but says that a general increase of yield marks his crops, and that he believes "steam cultivation, which means better cultivation, to be the cause."

This season Mr. Hemsley has done little cultivating, but (on November 10) had just drilled two fields of wheat upon early-steam-tilled clover-lea, that he could not have got in at all if it had been left for horse-ploughing. He averred to us that he "would give a thousand pounds rather than farm without a steam-tackle;" and considers that "sixpen'orth of coals does the work of one horse."

In March, 1861, Mr. Hemsley bought a Tuxford and Sons' 10-horse portable, and a Woolston apparatus made by Howard; consisting of a windlass, &c., a cultivator, 2½ feet wide, another, 4 feet wide, and a drag, 5½ feet wide; the engine costing 278*l.* 9*s.*, and the tackle ("second-hand," with a new rope) 133*l.* 15*s.*, to which was added a new 13-tine drag, 10*l.*; making the whole prime cost 422*l.* 4*s.* The total cost of repairs for 5 years has been,—on the engine about 27*l.*, and on porters, cultivators, new shares, windlass, axles, &c., 35*l.* 10*s.*; or, accurately, 62*l.* 12*s.*; or 12*l.* 10*s.* 5*d.* per annum. The apparatus has not been let out; but the engine thrashes, grinds, and cuts chaff occasionally. The cost of coal (at 16*s.* per ton, including 3 miles' cartage) is 7*s.* a day. One gallon of oil serves for 12 days; equal to 5*d.* per day. The water, 350 gallons per day, is carted a quarter of a mile, on an average, by an old horse, worth 2*s.* 6*d.* a day. The engine-man has 2*s.* 6*d.* a day; two anchor-men, 2*s.* 3*d.* each; windlass-man, 2*s.* 3*d.*; ploughman, 2*s.* 6*d.*; porter-boy, 1*s.* 2*d.*; and water-boy, 1*s.* 2*d.*; amounting to 14*s.* 1*d.* per day; no work being done by measure. When not steaming, the engineer is employed in shoeing and general smith's work at the farmstead, and the other hands on the farm. A removal takes 4 horses to the engine, 2 to the windlass, and 2 in carts with the porters, anchors, &c., if all the tackle is moved at once; and the time occupied is two to three hours, according to distance. The dif-

ferent sized cultivators and the drag get over 4½ acres, 7 acres, and 9 acres respectively, of very stiff work. Mr. Hemsley, coming to the same conclusion as many other "steam" men, does not mean to trust any longer to one sort of implement only, and intends "purchasing a plough very shortly." His year's work occupies 93 days. No account has been taken of hindrances from weather, as he works only when it is dry; but last autumn he lost about 10 days "from the engine."

No. 63. Mr. Edward Paddison, of Ingleby, near Lincoln, occupies 520 acres arable, and 200 acres of grass land, all pretty level; "Ingleby Farm," consisting of heavy loam upon a clay subsoil; while "Branston Farm," on Lincoln Heath, has a stony and sandy soil. The steam tillage is mainly practised upon the former; the apparatus being a Fowler 14-horse set, with plough and cultivator, purchased in April, 1866, for a total outlay of 950*l.* The fields are principally of 18 and 20 acres each, and smaller inclosures are being thrown together. Only the cultivator had been used at the time of Mr. Paddison replying to the "schedule of queries," and the work done was from 7 to 15 acres in a day, according to the depth and difficulty. Three men and three boys, at 11*s.* a day, for the force, work the tackle; water is carted by one horse with a man or boy. Shifting takes 3 horses for about 2 hours. The fuel consumed is half to three-quarters of a ton of coal, at 13*s.* per ton.

Mr. Paddison had let out his apparatus on two farms, and cultivated about 60 acres twice over for 17*s.* per acre. He intends setting the engine to grind and cut chaff. No difficulty has been experienced in getting labourers to work the steam-plough; the engine-man is the farm-blacksmith, and the others are ordinary farm hands. The clay farm used to require 14 horses, and now Mr. Paddison thinks that 9 will be sufficient.

No. 64. Mr. J. R. Ealand, of Aisthorpe, near Lincoln. Seven miles north of Lincoln, on the western edge of the "Heath" or "Cliff," or oolite-limestone range, and looking over the valley of lias-clay and boulder-drift toward the Trent, we find Mr. Ealand's residence; his farm of 700 acres arable, and 180 of old pasture, being one-half on the Heath and the remainder in the Vale. The hill fields have a good loam soil, being what is called "first-rate Cliff," with a deeper staple than is commonly found over the limestone; the largest part of the fields in the Vale consist of heavy blue clay, with brown clay under it, or in some places gravel, and round boulder-stones occur amongst the clay. The other portions of the Vale fields are of heavy loam. Ploughing used to be done 7 inches deep for fallow, with 3 horses, or with 4 horses on the heaviest land; shallower work for wheat. Six ploughs, with 6 men, 6 boys, and 18 horses, turned

over less than 5 acres a day, but the work was beautifully done; the cost, 13*s*. or 14*s*. per acre. The lands, never very high-backed, were levelled before steam culture was begun, and all well drained, 4 feet deep, at 8 or sometimes 9 yards apart. The clay land was laid flat gradually, and has been so for several years, yet, in spite of the present wet season, no water whatever has troubled them—the yearly rainfall here averaging about 25 inches. The fields also were squared, the fences made straight (which is most important), trees cleared away, and the inclosures made to average 30 acres each. This farm (Mr. Ealand's own property) lies remarkably well for steam tillage; a good public road dividing it into two portions, with a stream flanking the road, so that the engine can traverse alongside of (or not far from) the brook; and, when required, a man can water the engine by bucket, without the help of horse and water-barrel.

In April, 1865, after two years' experience of hiring a steam-plough, Mr. Ealand purchased a 14-horse Fowler engine (a traction and self-steering engine) for 614*l*., with 4-furrow plough, 97*l*.; 7-tined cultivator, 70*l*.; anchor, 55*l*.; rope, 84*l*.; porters, 25*l*.; and water-cart, 25*l*., making a total outlay of 970*l*. Mr. Ealand's "repairs" for a year and a half have amounted to 10*l*. 15*s*., which included the renewal of the large wheel of the anchor, and some smaller matters. The engine does all the heavy work of the farm (including a little on the Heath, but mainly in the Vale). In 1866 it did 70 days' work of cultivating, ploughing, and digging before harvest, and tilled about 100 acres afterwards, besides being 54 days in thrashing corn,—which, he says, saves him 55*l*. a year. The engine never goes out for hire; for, having used his tackle fairly and carefully, Mr. Ealand says he will not be set to the roughest and hardest work that farmers cannot do with their horses, and it would be of no use if he could not earn 5*l*. a day. The hands that work the tackle are four men and four boys, paid by the day, namely—engine-man, 3*s*. 6*d*.; ploughman, 2*s*. 9*d*.; anchor-man, 2*s*. 6*d*.; water-cart-man, 2*s*. 6*d*.; and the four boys 7*d*. each—*plus* a little beer, given only in hot weather. Four boys are used in "portering," when it is rough work, as in crossing a fallow, in which case a boy can work only two porters properly. This abundant help takes care of the rope; when at good work only three boys are employed. Ordinary wages are 15*s*. a week, and these hands are employed on the farm when not with "the steamer." Mr. Ealand's observation of the way in which the man used to drive so as to rack the engine, when he hired a steam-plough, decided him against acreage payment of the men. Instead of this he gives good daily wages, and after harvest the working hours are

from 6 in the morning to half-past 7 at night; and later in the autumn, from 7 till 6 o'clock.

Fetching water, about "7 tons per day," is done sometimes by the man alone, sometimes with horse and cart. In shifting, 2 horses are wanted; if on rough land 3 horses, for two or two and a half hours. Few difficulties occur, although they have had "a stick-fast." The consumption of coal is 14 cwts. in 10 hours, at 12*s*. 6*d*. per ton; oil and grease, 1*s*. per day. The average daily performance is 6 acres of ploughing, 5 acres of digging, if very deep upon heavy land, or 12 acres of cultivating on heavy, and considerably more on light land.

The results at present are that 24 horses have been reduced to 18, and these are not anything like so well kept as before, never being required for any really tough work. Mr. Ealand does not note any effect produced upon the general manual labour of the farm. The drainage is decidedly better, and a much larger breadth of roots is grown; and as he does not now dead-fallow so much as before, he grows more crops of grain. He has experienced no loss of wheat, because he has not ploughed deep for that crop, though he sometimes cultivates deep for wheat, early in the season when he can let the land lie. There has been a decided increase of yield, though Mr. Ealand cannot say (as some steam ploughmen do) "one quarter per acre." This year he has the finest mangolds he ever grew. He says, "I am quite satisfied that much more produce can be obtained by steam-power than by horses at any cost, on *strong land*." He said to us, "If you can't make strong-land farming pay with steam, I defy any man to do it without." He made use of a familiar phrase about giving so many shillings per acre rather than farm without steam. The meaning obviously is, that he is satisfied with his Fowler tackle; and he considers that a steam "grubber" alone could not possibly do his work, namely, some 600 to 700 acres of ploughing as well as cultivating in the course of a year. In fact, said he, "I would not be without it for any money." But his farm had been properly prepared for this system. Owing to his success, both his brother and brother-in-law have started tackle of their own, but being light-land farmers they considered that Howard's apparatus would best answer their purpose.

A new rope has not been required yet, great care having been taken with it; and though the rope was not "dressed" before winter, it was put away when very clean, and came out at spring-time quite bright.

The apparatus has not been in use long enough to afford fair data for the calculation of total expenses.

Selected items of information are here gathered into columns for ready presentation, but not for being added up and averaged:

Reference No. of the Farm.	Acres Arable.	Nature of Soil.	Apparatus.	Horse-power of Engine.	Acres Ploughed per Day.	Total Cost per Acre.	Acres Cultivated per Day.	Total Cost per Acre.	Total Yearly Cost of Steam Tillage.	Reduction in Number of Horses.	Number of Horses now kept to each 100 Acres.
48	220	Stiff clay ..	Smith	8	..	..	4½ to 5	..	..	10 to 7	3
49	300	Clay, upon chalk	Chandler	8	..	..	5 to 7	..	..	16 to 12	4
50	307	Clay	Howard	10	..	..	6	..	..	15 to 10	3¼
51	445	Heavy	Howard	10	..	..	6, 8, to 11	8*s.*, 6*s.* or 4*s.* 6*d.*	..	..	..
52	400	Clay	Howard	8	..	..	5 to 7	..	..	20 to 14	3½
53	550	Heavy and light..	Smith	10	..	..	8, 14, to 20	..	..	20 to 18	3¼
54	500	Clay and loam ..	Howard	10	..	..	7 to 8	..	..	22 to 16	3¼
55	400	Heavy	Hayes	10	..	..	5 to 8	..	..	..	..
56	800	Loam and clay ..	Howard and Smith	10	..	..	6 to 7	..	..	..	..
57	285	Clay and limestone	Smith and Fowler	10	4	..	7	..	..	14 to 9	2¾
58	375	Strong loam ..	Fowler	14	6	..	12	..	..	14 to 11	3¼
59	500	Clay	Howard	10	..	..	7	..	About £163	18 to 14	2¾
60	570	Clay	Fowler	14	5 to 6	..	8 to 11	..	About £300	22 to 14	2½
61	306	Clay and strong..	Fowler	Two 10	..	..	16 to 17	..	..	16 to 8	2⅔
62	332	Heavy	Smith	10	..	..	4½, 7, to 9	..	..	12 to 8	2½
63	520	Clay and light ..	Fowler	14	7	..	15	..	..	5 saved	..
64	700	Clay and loam ..	Fowler	14	5 to 6	..	12 or more	..	..	24 to 18	2½

Division 2.—*West.*

No. 65. Lord Sudeley, of Torrington, Winchcombe, Cheltenham, Gloucestershire, worked a Howard set of tackle with a 10-horse engine, in 1864-5, but that one year's experience proving that more power was needed on strong land and in very deep work, a 12-horse engine was procured; the tackle now consisting of one of Messrs. Howards' traction-engines, with boiler placed transversely across the framing, which carries two winding-drums, of snatch-blocks, anchors, porters, &c., for the "roundabout" system, 1600 yards' length of rope, a 5-tined cultivator, a 3-furrow plough, and a "traction-waggon," the total cost being 968*l.* In a year and a half the "repairs" have amounted to 34*l.* 2*s.* 10*d.*, chiefly from breakages of wheels or pinions, which were made of cast, instead of malleable iron. The working expenses are—labour, four men and four boys, 15*s.* a day; water, sometimes carried by boy, sometimes fetched by horse and cart, average 2*s.* per day; removal, taking 2 horses to haul out the rope, occupies an hour and a half to take up and set down, exclusive of time spent in travelling; oil costs 1*s.* 3*d.* a day; and coal, at 17*s.* to 19*s.* a ton delivered, costs about 12*s.* 6*d.* a day. The fields (now altered for the purpose) average 20 acres each; the soil is very tenacious, the subsoil a very stiff blue clay, and the surface hilly, presenting some steep inclines; and under these conditions the steam-plough turns over about 3½ acres per day, with furrows 10 to 12 inches deep. Last year the cultivator averaged about 4¼ acres per day, including removals and stoppages.

The farm has only 100 acres of arable, besides 160 acres of grass; and the apparatus is let out for hire, having worked upon ten different farms last year—on terms which will be noticed in our Section on the Hiring System.

Mr. Thomas Colsey, the agent, reports that the drainage is considered more effectual after the steam tillage, that root crops [illegible]e fed-off with more advantage, and that a considerably larger breadth of roots is now grown. The team-force kept consists of [illegible] horses.

No. 66. Mr. Edward Holland, M.P., of Dumbleton Hall, [illegible]stershire, near Evesham, Worcestershire. Sheltered in [illegible] [illegible]ley south of Evesham, which divides the northern spurs [illegible] Cotswolds from Bredon Hill (a bold feature in the land[illegible]ape for many miles around) we found the Hall, and Park, and [illegible]illage of Dumbleton. Mr. Holland's farming extends over [illegible]50 acres, of which 367 are arable; the "Hill Farm," having [illegible] acres arable, of stonebrash with intervening beds of clay, [illegible] "Cullabine Farm," in the vale, has 236 acres arable, of [illegible] [illegible] clay, with a covering in places washed from the

oolite hills, but neither gravel nor stones to grind his steam-plough rope. There is no lime in the neighbourhood. The custom of the country is to plough 4 to 6 inches deep by 4 horses; the fields laid up into high-backed lands. And Mr. Holland has found it necessary to keep to the old serpentine water-furrows in his deep-pipe drainage—the parallel system not being found to answer. He has gradually levelled his ridges, by working the steam-cultivator diagonally across them, thus wearing them flat in a course of years. And, when so done the land drains well, drying very much faster under steam tillage than it used to do under horses; still, though the superficies is now flattened, water-furrows have not been abandoned, there being, of necessity, a "water-table" in these fields presenting very gentle gradients. A piece of globe-mangolds was shown us, where the ridges have been only partially lowered, and this too quickly; the effect being visible in two stripes of inferior crop upon each ridge, half-way between the crest and the water-furrows.

The inclosures are spacious, ranging from 17 to 100 acres; and a straight hard road has been formed through a portion of the vale farm, from which the engine (a Fowler) can command the fields on both sides. Seven years ago Mr. Holland purchased a 10-horse power single engine, and anchorage, Leeds tackle, which was subsequently enlarged for a 12-horse set; the first cost being 730*l.*; exchange of tackle on making exchange of engine, cost 10*l.*;* and the addition of a Fowler cultivator, 60*l.*; making a total present investment of 800*l.* The breakages, repairs, and renewals of rope during the seven years have cost about 400*l.*, or 57*l.* a year. About 100 days' work have been done in each year; the annual performance, however, is accurately given in the following Table:—

Acreage of Land Ploughed and Cultivated in one year, including Removals, and Stoppages from Weather or other causes.

	Acres Ploughed.		Acres cultivated.		
1865.—September	..	....	136		
October	18	....	140		
November ..	54	....	5		
December	44	....	..		
1866.—January	25	....	..		
March	..	....	17		
April	..	....	17		
May	10	....	..		
June	..	....	10		
	151	+	325	=	476 acres.

Part of the work (a large quantity upon a 367-acre farm) was

* The payment on exchange was 40*l.*; the total cost 830*l.*—E. H.

repetition over the same fields, the proportion of the farm steam-tilled having been 220 acres. The whole time engaged was 79 days, making the average daily performance a trifle under 5 acres, but then it is very deep. From this we can compute the cost of rope and repairs to have averaged 11*s.* 9*d.* per day, or 2*s.* 5*d.* per acre; out of which the cost of rope would probably not exceed 10*d.* an acre, as one rope lasted four years. The outlay for other "repairs" has thus been 1*s.* 7*d.* per acre. But from the fact that Mr. Holland was obliged to part with the 10-horse engine, which was too weak for his purpose, we may conclude that the same average yearly expense is no longer applicable to the steam-working at Dumbleton, and that the more powerful and also more perfected apparatus will reduce the item of repairs for the next seven years.

Five years ago, Mr. Holland began paying his steam hands by the piece, giving them 4*s.* 6*d.* an acre for ploughing, and 2*s.* 3*d.* for cultivating; the force consisting of 4 men (men being employed instead of lads to shift the porters) and one boy with the water-cart. A full day's work gets over 5 to 7 acres of ploughing, or 7 up to 10 acres of cultivating, 10 to 12 inches deep. The consumption of coal is 10 to 12 cwts. a day, at 12*s.* to 13*s.* per ton. The oil costs 1*s.* 6*d.*, the water-cart horse, 3*s.*, and for removal, with the help of 2 horses, we may put perhaps 6*d.* upon each working day.

The apparatus is not let on hire, but the engine is occasionally used for sawing and thrashing, though only for a small part of the thrashing of the whole farm; so, making an allowance for this, we may reckon the 5 per cent. of interest on say 730*l.*, and the 5 per cent. of depreciation on say 600*l.* Collecting all these data, we arrive at the following expenditure for one year:—

	s.	*d.*		£.	*s.*	*d.*	£.	*s.*	*d.*
Labour:—									
151 acres, at	4	6	=	33	19	6	70	10	9
325 acres, at	2	3	=	36	11	3			
Water-cart horse, 97 days, at 3*s.*							14	11	0
Removals .. 97 days, at 6*d.*							2	8	6
Coal .. .. 97 days, at 6*s.* 10*d.*							33	2	10
Oil .. .. 97 days, at 1*s.* 6*d.*							7	5	6
Repairs, and rope							57	0	0
Interest							36	10	0
Depreciation							30	0	0
Total yearly cost of steam cultivation							251	8	7

The average per day is 2*l.* 11*s.* 10*d.*, and per acre, 10*s.* 7*d.*

What return does Mr. Holland obtain for his 251*l.* expended in steam cultivation? It so happens that, unlike most employers of steam-tackle, he has not reduced the head of horses on his farm. But then this fact is susceptible of a very satisfactory

explanation. Before the engine came, 25 horses were kept; of which 20 may be considered the working-team. But now there are only 8 working horses, the remainder of the old number, 25, being made up of mares in-foal, or "with foals at foot," and young working colts. These colts are able to do a portion of the lighter work now required from horses, and instead of being quickly used up, as the farm-horses used to be, are always of marketable value, and improved till sold. It appears that Mr. Holland's steam-plough has really displaced 10 or 12 horses from his former team, the rest of the present horses being kept as ordinary breeding and feeding stock, instead of horned cattle. Hence the annual return by saving in draft-labour may be taken as 10 horses at 44*l.* = 440*l.*, or 12 horses at 44*l.* = 528*l.* So that Mr. Holland is well paid for his outlay of 251*l.* in steam tillage. The manual-labour bill, he informed us, is not at all curtailed. Steam culture has enlarged the breadth of root-crops, the land having been previously too stiff to grow them. When wheat is to follow, it is found better to draw and cart off the roots, than to feed them on the ground by sheep. Then the acreage of wheat has been increased by steam culture, wheat being now grown every other year, which never could be done under the horse-management. The alternating crops are beans, peas, mangold, and cabbage. As to greater yields, Mr. Holland says that the average weight of roots per acre is not much more than it was; but with regard to grain-crops (to quote his own words), "by my own experience, and by comparing notes with other steam-power employers in this locality, I think it may be said that the increase per acre attributable to steam cultivation may be put at 8 bushels per acre."

This is remarkable evidence: the steam-plough appears to gain Mr. Holland from 190*l.* to 270*l.* a year by saving in tillage-labour; it gains him a quarter of wheat, say 2*l.* 10*s.* per acre, over half his farm, or 450*l.*; which together amounts to 640*l.* or 720*l.* a year; equivalent to nearly 2*l.* per acre on all the arable land! Then, beyond this, a further profit must accrue from the extra quantity of roots which feed more live stock.

We may remark that the root and pulse-crops are highly manured with long dung from yards, stalls, and boxes; and this management, with deep and thorough drainage, and the application of burnt clay (as well as the deep steam tillage), have all had their improving effect upon the soil. Mr. Holland's corn-crops are evidently very superior, judging both from his stubbles and the splendid show of stacks, which extending over more ground in an enlarged rick-yard, give palpable evidence of the results of steam-ploughing. We would here add that farm engineers may take important hints from sundry arrangements pecu-

liar to Mr. Holland's buildings: not alone the cooking of chaff by waste steam from a fixed engine, entering a chaff-receptacle through a perforated iron bottom, or the raising and lowering of the feeding-troughs in the cattle-boxes by a ratchet-barrel and chains, but more especially the appliance enabling one fixed steam-engine to thrash most of the ricks where they stand in the large rick-yard. A driving-shaft about 144 feet long is mounted upon brackets outside the barn-wall, and under cover of a projecting eave; it carries a band-wheel opposite each open space between two ricks,—that is, five of these riggers for ten wide-steddled round stacks; and a portable thrashing-machine is driven by a belt from any of these wheels in turn. By this contrivance (which has worked here for eleven years) the engine in its house thrashes probably 400 quarters of corn in the rick-yard. The remaining stacks in the additional plot of yard, being out of reach of the shaft and belt, are knocked out by help of the steam-ploughing engine.

In conclusion, we may observe that, at the date of our visit (middle of September) wet as the weather was and had been for a long time, we found a clay-burned field lying in a splendid tilth for wheat-seeding, with a broken-up staple soil now nearly a foot deep, which is about double what it was under the *regime* of the 4-horse team and sledging-plough.

No. 67. M. C. Randell, of Chadbury, Evesham, Worcestershire. Knowing this to be the tenth year of Mr. Randell's experience in steam culture, we expected a good lesson from him, and, as this Report will show, we were favoured with exceedingly valuable information.

The farm of 430 acres arable, and 220 pasture, consists for the most part of stiff blue-lias clay, some of the surface presenting very steep acclivities; while a small portion of sandy land, overlying a conglomerate gravel, reaches down into the rich valley of Evesham, under the northern edge of "the Cotswold range;" and from this lighter land lying next the public roads, passers-by conclude the farm to be of less tenacious character than it is. The average size of the inclosures is 22 acres, bounded by the neatest of fences; and there has been no necessity for remodelling inclosures, stocking-up wasteful plantations, uprooting field-timber, or laying out new roads, to give full play to the steam-horse, as all this was done by Mr. Randell when he entered upon the farm 28 years since. One great improvement effected long since, and still in operation wherever requisite, is clay-burning. We walked (or rather climbed) up a steep-hill field of clay, which underwent this ameliorating process 25 or 26 years ago: the rye-grass here was broken up by the steam-cultivator (able to mount any gradient or dive into any hollow) in July, 1866, and the

burnt bits are still plentiful; the "brick," which has a tendency to sink, is continually brought up again by the deeply-burrowing and upturning tines of the cultivator, and the texture of the soil thus permanently kept milder and more free-working. This said piece has never been dunged within the memory of man: a high degree of fertility has been maintained by draining, burning, deep tillage, and feeding-off vetches by sheep supplied with oil-cake; while 3 cwts. per acre of guano are applied for wheat. Mr. Randell keeps more stock than he formerly did, in consequence of having more produce for consumption. But then a peculiar feature in his system is, that none of the sheep are wintered on the clay-land, but in yards bottomed with burnt clay, renewed from time to time, and removed with the urine absorbed and the droppings incorporated with it into a fine manure. So that this land is not subjected to the pugging of the feet of a flock, the feeding off of vetches being, of course, a summer or dry-time operation. On the vein of lighter land we saw (in September) the Shropshire tegs grazing a superb stock of thick-stalked leafy rape, through iron hurdles propped leaning from the fold; the best possible plan for preventing waste, and saving the young sheep from a life of uninterrupted damp or wetness in wandering under the branching greens, or lying upon the cold half-eaten stalks.

In 1857 Mr. Randell bought a Clayton-and-Shuttleworth 10-horse portable for 250*l*., and a Smith tackle (with 3-tined grubber), made by Humphries, of Pershore, costing 200*l*. Since then a Howard 3-tined grubber has been added, and a Fowler 3-furrow plough lately purchased at 130*l*. more; making the whole investment 580*l*.* Heavy expenses were incurred during the first few years of apprenticeship, caused by such accidents as the drum-flanges breaking and cutting the rope to pieces. Latterly the breakages have been very trifling, though the wear of rope is a heavy item: the repairs (chiefly consisting of renewal of rope) have amounted to 230*l*., or an average of about 25*l*. a year; and as the annual performance (with average seasons) has been 230 acres, the direct "wear and tear" has been 2*s*. 2*d*. per acre. We can easily calculate, then, what it costs Mr. Randell to keep a steam-cultivating machine permanently efficient. No work is done for other people; but the engine is employed in the farm-thrashing; how many days in a year is not stated, but, on a farm cropped like this, we may safely say for 25 days; while, at the daily rate of work stated by Mr. Randell, the tillage (with removals and stoppages) must have occupied about double that time. We have thus to deduct one-third the

* The plough cost 60*l*.; the whole investment was 530*l*.—C. R.

prime cost of the engine, as chargeable to the thrashing account, before we reckon the 5 per cent. of interest that is to be set on steam cultivation. On 497*l.*, then, the interest will be 24*l.* 17*s.* a year. Depreciation, at 5 per cent. upon the cost price, minus the rope and other wearing parts, say upon 400*l.*, will be 20*l.* a-year. Here, then, we have an apparatus maintained at an expenditure of 70*l.* a year; not for two or three years only, but for more than nine years, and so maintained that it is still in good working order, and not at all likely to be broken down or out of fashion at the end of nine years more. Throughout this time the machine has accomplished all the heavy tillage required of it by Mr. Randell's system of farming upon 430 acres arable. Had the farm been of double this size, of course the wear and tear would have been correspondingly greater. Then, either the interest and depreciation must have been augmented, or else the tillage operations must have been backward, and the results in cropping and produce inferior. To be equally forward with the same grubbings and ploughings upon an 800-acre instead of a 400-acre farm, two fields in the former case must be finished in the same time as one in the latter; involving the use of a more powerful set of tackle, and proportionately swelling the outlay of percentage on the purchase-money. We mention this very obvious circumstance to prevent inconsiderate persons from concluding that, because Mr. Randell's 70*l.* a year finds him a competent piece of machinery for all he wants of it on a 430-acre farm, therefore a precisely similar tackle, with the same figure of investment, will do as much for them. It will, provided their farms are of like magnitude and character to that of Chadbury, and managed as thoroughly on the same system. The questions, What should be the form of apparatus, and what its capability of performance per day, for a farm of any given area?—must be answered, not by reference to one successful example, but by a comparison between many good cases on different-sized occupations,—such as are furnished to the reader in this Report.

The pecuniary part of Mr. Randell's experience is not yet fully presented. Let us see what are his expenses per acre, at the rate of 4 acres per day of cultivating the first time over, and 6 acres per day of crossing: for on this strong land, and with this apparatus, and the engine worked at only 60 lbs. pressure, the performance is not found to be more. It takes one hour to get up steam; a removal occupies two hours, with 4 horses and the steam-hands, and occasionally some delays by breakage. These vary much in the amount of time wasted; in very hard work, and when the rope is a good deal worn, the rope sometimes breaks two or three times a day, losing half an hour each time for "splice." A removal, about every fourth day, may be

put at 1*s.* 2*d.* upon each day's work. Carting 500 gallons of water from a field well costs 4*s.*; the boy who does the driving and pumping having also to oil the rope-porters. The oil used is 1¼ pint, costing 1*s.*; and the coal, at 12*s.* per ton, has cost Mr. Randell 9*s.* a day. The tackle is manned by six hands—the engine-driver at 2*s.* 4*d.*, and five other men (none of them lads) at 1*s.* 10*d.* each, all being ordinary farm-labourers.* Working expenses per day, then, stand as follows:—

	£.	*s.*	*d.*
Manual labour	0	11	6
Water-carting	0	4	0
Share of removal	0	1	2
Coal	0	9	0
Oil	0	1	0
Working expenses per day ..	1	6	8

Thus, the working expenses per acre, are 6*s.* 8*d.* for cultivating first time over, at 4 acres a day; and 4*s.* 5*d.* for crossing, at 6 acres a day. Add the repairs and wear of rope, which, we have seen, are 2*s.* 2*d.* per acre, and the cost comes to 8*s.* 10*d.* and 6*s.* 7*d.* per acre respectively. The work done in a year consists of 113 acres of stubble broken up once over in autumn, and 79 acres of seeds broken-up once over in July, for wheat—making 192 acres done once. Then 39 acres of the 79 are crossed, making 231 acres altogether. The 192 acres at 8*s.* 10*d.*, and the 39 acres at 6*s.* 7*d.*, bringing the yearly working expenses to 97*l.* 12*s.* 9*d.* Adding the before-named 70*l.* for the machinery, we get a total of 167*l.* 12*s.* 9*d.*, or 14*s.* 7*d.* per acre, as our estimate of Mr. Randell's whole annual outlay upon steam cultivation.

This is not specially cheap work, as far as the cost of execution is concerned. But steam-power husbandry has taught us this lesson, that there may be a wide difference between what a tillage operation is "worth to do," and what it is "worth when done." For how does Mr. Randall's account stand in the long run? He now works 16 farm-horses, which, at 44*l.* a piece, cost 704*l.* a year. So that his total expenditure upon draft tillage, both by steam and horses, and upon the carriage-hauling of the farm, amounts to (704*l.*+168) 872*l.* How much did his draft cartage and draft tillage cost him before the steam-engine came? The extent of the farm having been altered since that time, the original number of horses will not afford the right comparison; but Mr. Randell considers that the normal force due to the present area of arable, supposing he had no steam-cultivator, would be at the very least 6 horses more than he now

* Wages are now 2*d.* per day higher.—C. R.

keeps, or, in other words, 22. These, at the same rate of 44*l.* each, would have cost him 968*l.*; that is, the total outlay for draft labour would have been 96*l.* a year more than at present. Now, if instead of keeping a steam-cultivator himself, Mr. Randell (with his present reduced force of 16 horses) had paid some one else to come and do the steam tillage for him (the owner of the tackle finding everything), he could have afforded to pay for this work not only the 168*l.* which it actually costs, but also 96*l.* besides, without spending more in draft labour than he did before. That is, the 230 acres of steam tillage, though costing 14*s.* per acre to do, may be valued at 23*s.* per acre, without increasing the old disbursements in Mr. Randell's ledger. As the case actually stands, our reckoning shows that the outlay for steam-work is 168*l.*, and that the 96*l.* a year are into pocket; or, in other words, the draft labour of the farm costs 96*l.* less than it formerly did. As a matter of fact, we believe that the economy is even more considerable, for Mr. Randell assured us that not only had the steam-engine spared him at least 6 horses, it had also lightened the labour of the remaining 16, so that he works them less severely than before, and consequently at less expense per head for maintenance. We should here remind the reader that the sum of 44*l.*, adopted by us for the total yearly cost of a farm-horse is possibly greater (it may be less) than Mr. Randell would allow for his teams; it is adopted throughout our calculations, and is explained in the introductory part of our Report.

It may be thought that we have not made out any very wonderful results from exchanging half-a-dozen horses for a steam-tackle. Well, we have been treating only of the direct money saving; now comes the effect upon the farm produce, which, after all, is the great thing to be considered. Mr. Randell admits that his wheats are neither better nor worse than when the farm was entirely under horse culture, for they have averaged 40 bushels an acre for many years. His other produce is greatly increased, because he now grows a larger breadth of roots, more mangolds and cabbages, and a smaller acreage of tares; and these crops are heavier in consequence of the preparation for all being completed earlier, and more of it done in dry weather, which "is all-important," he says, "on such land." More food enables him to keep more live-stock, and necessarily the manual-labour bill has increased rather than diminished. More rye-grass also is now grown, in place of beans, &c., for the objection that it is a bad preparation for wheat no longer holds good under steam culture; being now smashed up early it has time to get a solid bottom, and the wheat-plant does not suffer as it would if the lea were ploughed. We saw a striking example of directly augmented yield from steam tillage in a field of mangolds—all treated alike

as respects the number of operations, in the manure applied, and in the time of sowing—and the roots after "steam" were much better than those on the horse-ploughed part. This crop followed rye-grass, and the sward being hollow after the ploughing, the roots did badly, suffering from drought.

"The grand thing in steam culture," said Mr. Randell, "is being able to take advantage of favourable weather for tillage, and more particularly in the autumn culture for roots and cabbage." And the fact that the land is generally "stirred only once" for a green crop will account for the comparatively small amount of tillage requiring to be accomplished in the course of a year. This clay soil, it should be remembered, is not very prone to mat itself with couch, or so difficult to clean when foul, as some moist light lands are; it is principally subject to that noxious weed called the "onion twitch."

A few of Mr. Randell's practical deductions are these—steam-grubbing is essentially a dry-weather operation, and though, in general, it is the fundamental process in his tillage management, he could make little use of it during the wet season of 1866, and consequently recommends the turnover-plough as the implement to be resorted to in such a time. He likes the Woolston 3-tined cultivator better than the Bedford 3-tiner, because the former always works with a single tine preceding the other two, whereas the Bedford does this only one way—in every other journey the 2-tines go first, sometimes lifting the soil in one unbroken mass. But this backward-and-forward implement is admirable for crossing. He cultivates straight up as well as down very steep and lofty hills, as sidelong working would not do; and he does this with ease, where horses were always obliged to plough down, and go up "empty." He does not trench-up land for winter, and has not tried the steam-drill. There has been no difficulty whatever in moving the engine about. To get over a great breadth of ground in the most precious season, the men make 7 days in a week by working 2 hours extra every day. Mr. Randell once tried paying by the acre, but he lost by the experiment—the work was scamped.

The drainage is rendered more effectual by the steam tillage; Smith's grubber tearing up masses of clay much deeper than the tool is set. On one field, hollow in the middle, water used to lie for 24 hours after a heavy downfall; but this has not been the case, since the engine broke up the ground below the old staple. More roots can be advantageously eaten by sheep on the land, because the preparation of autumn-culture gets them sooner ready for stocking; still, the ground does not bear treading in wet weather any better than before.

Mr. Randell does not believe in parallel drains for clay land;

he says, "Stick to your furrows," and if you must level ridges, take care to have the course of the drains duly marked on a plan. Where ridges are very high, it is an expensive process to flatten them, though Mr. Randell will not say that, in course of time, it may not answer. His own experience is, that laying a clay quite flat does not answer; there must be some water-furrows. Where the land is "slightly arched" between the water-furrows, he can steam-grub for wheat, without needing to plough afterwards; but he does not like to venture his wheat upon a surface perfectly horizontal. This testimony, it should be remarked, is applicable to a blue-lias clay in a locality having an average rainfall of probably 30 inches.

In reference to some of the points we have just named, the following letter from Mr. Randell (January 21st, 1867), is important. He says:—

"My practice, since I adopted steam cultivation, has been to manure the land intended for mangolds immediately after harvest; then smash it up, the rougher the better, by Smith's 3-tined cultivator. If an opportunity occurred of ploughing afterwards (by horses) during a frost, I have done so; otherwise the land has had no ploughing; it has been only scarified in the spring, to destroy surface weeds, first being looked over by men forking out all couch grass. This has been all the preparation for mangolds, which have been then drilled on the flat with 1½ cart-load of ashes from the sheep-sheds, mixed with 3 cwts. per acre of superphosphate of lime. They have been afterwards top-dressed with 5 cwts. per acre of Peruvian guano, horse-hoed in. The treatment for cabbages has been the same, as far as manuring and smashing up the stubble-land. The plants are set by hand in October, as soon as the clods will fall to mould under a pair of harrows.

"So far, as to clay land. I have some lighter land on which turnips and swedes are grown; also on the flat, our climate not being moist enough for ridging. These crops follow tares or early cabbages, planted on wheat-stubble manured and ploughed (until last autumn) by horses. But having, last summer, purchased a 3-furrow Fowler's plough, this work was done last September by steam. Indeed, the last wet autumn quite changed my practice as to steam cultivation. In none of the nine previous years, during which I have used Smith's cultivator, have I had reason to think any other implement necessary; but in the last wet season it was entirely useless. 'Smashing up' will only do when the land is dry enough to burst up in all forms; if the tines cut, not burst, the soil only falls back to its original place, and the land becomes more wet and unkind for the operation. Without Fowler's plough I should not have moved an acre by steam last autumn; with it, we got over 87 acres very satisfactorily, at the same cost per acre as it had been done in other years by Smith's cultivator. So I come to the conclusion that there is good in all; Smith's for real hard work, Howard's for crossing Smith's work; and Fowler's for doing that which they cannot do. I have them all.

"I am, my dear Sir, faithfully yours,

"C. RANDELL."

No. 68. Mr. Peter Davis, of Bickmarsh Hall, near Alcester, Warwickshire. Three or four sets of the Bedford tackle are at work within a short radius of Honeybourne Station, in a district of stiff clay, high-backed lands, and ploughing by 4 horses

in a string. A few miles north of that place, between Evesham and Alcester, Mr. Davis farms 730 acres arable (and 245 acres pasture) of poor blue-lias clay; with beds of lias-limestone in a few of the fields, serving as natural drains to the land. No steep hill-sides exist upon the farm, and the country is generally level; yet it is customary to plough with 5 horses—Mr. Davis, however, using only four. The fields are of about 20 acres each, with sides straightened by the stocking-up of hedges and with but few trees. No changes have been made in roads. The "normal force" of horses on this farm would be 38 to 40, certainly not fewer than 36; the introduction of a steam-cultivator has enabled Mr. Davis to sell off fully half his teams, and to carry his tillage-work before him with only 18 horses. Perhaps a pair more would be advisable, as the land, though generally pretty clean, has a few "outsides" that would pay for a little extra working. Here, however, we have an extraordinary displacement of draft-animals, equivalent, at 44*l.* per horse, to a saving of no less than 792*l.* a year (at the lowest number of horses formerly wanted), or 968*l.* (at the highest number). Out of this, of course, have to be paid all the expenses of the steam tillage substituted. The extent cultivated or ploughed in a year is 360 acres, the depths of work being as follows:—In grubbing "bean-brushes" for wheat, 5 or 6 inches is not exceeded, Mr. Davis believing that deep stirring immediately before sowing is wrong; but for fallow, and especially if early in the season, the tines are set in as deep as possible—namely, 7 to 9 inches. The ploughing for beans or mangold is done at a depth of 9 inches. We have not ascertained what Mr. Davis's steam-work actually costs him; but even if we assign it the excessive sum of 10*s.* per acre, his total expenditure on steam culture will be less than half the lowest amount at which we put his saving in horseflesh.

In 1863, Mr. Davis bought a 12-horse engine for 340*l.*, and has a Howard tackle with 3-tined cultivator, costing 250*l.*, to which is added a Fowler 2-furrow plough, costing 45*l.* He had started with a Woolston tackle, but broke the cultivator, and cracked off the flanges of the rope-drums by the pressure of the coils. The Bedford apparatus has stood well, and, though the "repairs" have not been serious—having been chiefly done by a blacksmith on the farm—the wear of rope has been enormous, a new rope having been required about every second year; This will give some idea of the extraordinary tenacity of the clay, which, as already said, pulls 4 horses so hard in a common plough, that the country custom is to use five; and the 12-horse engine, burning 12 cwts. of coal per day (at 16*s.* per ton) ploughs or digs only 3½ acres a day, and cultivates 7 acres a day. Five men and 3 boys work the tackle, being paid 3*s.* an acre for

cultivating, and 5*s*. 6*d*. an acre for ploughing or digging. Water, 700 gallons in a day, is carted by one horse and boy. Shifting occupies 8 horses for 4 hours; that is, half-a-day, more or less, according to distance. The engine is used occasionally for thrashing, grinding, straw-cutting, &c.; but no steam-work is done off the farm.

In the absence of Mr. Davis, the son (as sound, intelligent, and business-like a young farmer as we have had the pleasure to pick up for some time) conducted us over the stubbles and fallows. The wheat-stubbles were wonderfully strong, and spoke well for something else besides wide-drilling—here 11 and sometimes 12 inches between the rows. Deep-tillage, young Mr. Davis assured us, does answer well for the wheat-crop; but then it must be done in July, or at any rate very early, and their tackle is kept busy throughout July, September, October, and November. Then the levelling of the old high-backed ridges he finds to be quite right; only it must not be done at once, but gradually, by working the steam-implements across ridge and furrow, so as in process of time to wear them horizontal. The drainage (thanks to steam cultivation) acts well on those fields which have already become perfectly flattened. The double-crop system is well-practised here: we saw beans in wide double rows, with very good turnips growing in the intervals. Root-crops are now grown to a considerable extent in place of dead-fallowing, and are consumed on the land by sheep. The chief alteration in the cropping has been the substitution of lucerne for clover, owing to the frequent failure of the plant.

In Mr. Davis's case, we may sum up the resultant advantages of steam culture thus:—He saves very considerably (indeed, we should say, very largely) in his outgoings for tillage; he greatly increases the acreage of root-crops; and his grain-crops yield far better than before,—all being attributed by him to "steam cultivation and thorough drainage."

In a letter, dated February 18th, 1867, Mr Davis says:—"I write to say that, since we finished cultivating in November, 138 acres have been *ploughed* for beans, peas, and mangolds, at a season of the year when none, except the roundabout system, is available. Now this, I consider, is a great object in a year like the last, when so much hindrance from wet weather occurred."

No. 69. Mr. Benjamin Bomford, of Pitchill in Warwickshire, near Evesham, Worcestershire, occupies 1200 acres, of which 900 are arable, geologically described as blue-lias clay, with layers of bluestone in some places, and a small portion consisting of conglomerate gravel. But there is a greater breadth of good heavy loam than of strong tenacious clay. The surface, level or gently undulating, is divided into large enclosures,

averaging 20 to 40 acres each, Mr. Bomford having shaped them "with a view to steam;" and, in one instance, ten little fields have been thrown into one. The farm is not overburdened with timber, and the greater part of the trees are profitable in a way undreamed of by farmers of many counties; they bear orchard-fruit. Noticeable among these are the Pershore plum, which are sent to the manufacturing cities from the district of Pershore by thousands of bushels, of which apricot-jelly is made! There has been no necessity for laying out new roads for the steam-horse—or, rather, for the steam-team—as Mr. Bomford works a pair of engines. And, as for travelling his ponderous tackle about these clay-fields, there is no difficulty whatever in reasonable weather; while he declares it a good thing that he cannot move his engines about in wet weather, as this keeps him from working when the land is not in a fit state. Opportunities have to be watched in a catching time; for one of the engines had to be left in a field all one winter, and came out (literally, for it was not pulled out, being self-locomotive) in spring over the wheat.

In February, 1864, Mr. Bomford procured a couple of 12-horse engines of Savory and Son, of Gloucester, constructed with a large shell-drum enclosing each boiler, on which the rope is wound in a single layer of coils, the two engines hauling the implement to and fro between them on the usual "double-engine" system. The implements used are a Fowler 4-furrow plough, a Fowler 7-tined cultivator, and a Howard cultivator made especially for Mr. Bomford, 7 tines instead of 5 tines in width; and the character these several tools have gained for themselves here is, that Fowler's cultivator is the best for breaking up whole ground; and Howard's, while too heavy in draft for this purpose, is the best broad one for "crossing." The price of the machinery would be 1200*l.*, though, in this case, the bargain was partly "a clump for other tackle." No exact account of repairs has been kept; but nothing very serious has occurred in breakage, and Mr. Bomford's own calculation is that the "wear and tear and repairs" will be covered by 7½ per cent., while 5 per cent. should be allowed for a renewal fund to buy a new set; to which, we suppose, 5 per cent. more must be added for interest of capital invested. This makes 17½ per cent. on first cost, or 210*l.* a year—a heavy sum; but then the amount of work done has been great, for the tackle has been employed for 100 days in a year. The daily working-charges are as follows:—Two engine-men, 6*s.*; one ploughman, 3*s.*; a water-cart man, 2*s.* 6*d.*; and two strong lads, 3*s.* 6*d.*,—the manual labour, well paid, amounting to 15*s.* These hands, when not steaming, are at ordinary work on the farm. One horse draws the water when within reasonable distance of the supply, say 2*s.* 6*d.* per day.

The engines move themselves and all the apparatus without the aid of horses, all this occupying less than half an hour, when the next job lies near; so that there is no expense to be added for removals, which simply account for themselves by slightly diminishing the average daily quantity of work done. Oil costs 2*s.*; and coal, 24 cwts., at 15*s.* a ton, costs 18*s.* a day. All these sums amount to 35*s.* per day, or, for 100 days, 175*l.* a year. As the engines are used solely for cultivation, and have done only 10 acres for hire, we have to add the whole of the above-named 210*l.* for the machinery—making the total yearly cost of steam tillage, 385*l.*; and the total cost of a day's work, 3*l.* 17*s.* What have we to post on the other page of the ledger? Probably more horses are kept in this neighbourhood than need be; 3, now frequently 4, horses plough a furrow 5 or at most 6 inches deep, but more are sometimes yoked, and always *tandem* ("at length"). But Mr. Bomford's engines have enabled him to sell off nearly 20 horses out of the 45 formerly worked; and, nevertheless, "the farm," he says, "is much better cultivated." At 44*l.* each, the saving thus effected has been 880*l.* a year; subtract the total outlay for steam cultivation, namely 385*l.*, and there remains a balance of 495*l.* a year (more than 10*s.* an acre over all the arable land) gained by the mere exchange of a part of the former horse-team for steam-machinery. Perhaps 44*l.* would not be Mr. Bomford's estimate, but he quite agrees that steam-power is the more economical.

We have now to relate what may be classed among the "extraordinary things" met with on our inspection-tour; although this double-engine tackle accomplishes as much work as 40 horses could do, in the course of one month's fine weather in September and October, Mr. Bomford is not satisfied with it; and for that reason he intended (so he told us)—not to get rid of it, but—to buy another; not in lieu of the present machinery, let it be understood, but a second "double-engine set," so that he may have two pairs of engines at work upon his farm at one and the same time! The reason is this: the present "set" is scarcely used till after harvest, when it is kept running every hour that may be possible; but so palpable are the benefits of early tillage, that Mr. Bomford wants to get all his autumn ground broken up within a fortnight or three weeks, which the present "set" is unable to compass, and therefore he was buying another to help it. This example is such an illustrative commentary upon the worth of rapid cultivation on a strong soil, that we must follow it out a little more in detail, for the consideration of those persons who cannot see why higher prices should be afforded for steam than for horse work. What does Mr. Bomford's tillage now cost him per acre? Of ploughing, he does 6 up to 10 acres a day

with ease, in large fields. A day's expenses (on his own estimate) we said, are 77*s.*, so that the ploughing costs from 7*s.* 6*d.* up to 13*s.* per acre. With the Fowler cultivator, the area per day, at a depth of 9 or 10 inches, is 8 up to 12 acres; the former quantity in specially hard work,—which is, to "bursten-up" hard-baked ground in autumn. The cost ranges from 6*s.* 6*d.* to 9*s.* 7*d.* an acre. With the wide Howard grubber, 18 acres have been "crossed" in a day, at a cost of 4*s.* 3*d.* per acre. These are not unusual cost prices of deep steam-work, and are higher than we have found on some steam-farms; but they are so far cheap that, considering the depth of the culture and the wonderful shattering of the soil by the exceedingly rapid pace of the implements, no force of horses could execute the same quality of work at all. Yet the resultant advantages have been so great, that Mr. Bomford is willing to saddle them with the additional interest, depreciation, and repairs of 1400*l.* worth of new machinery (that is, a pair of Fowler 14-horse engines which will "give out more power;") for, though some contract-work will doubtless be done, it is mainly upon these autumn operations that the additional expense will lie. And the additional cost per acre is ventured solely because the tillage, being executed in half the time, will be worth so much more money.*

So far, figures appear to justify the expectations of this energetic husbandman: let us see whether they are borne out by the testimony of his farming. In the first place, steam tillage has nearly doubled the depth of his staple for him; and all intelligent managers of good strong land will know what that means. On the lighter portions of the farm, early autumn cleaning is the chief thing conferred by the steam tackle; but, on the heavy land, a much greater benefit is derived from the simple circumstance of accomplishing the right process at the right time. Mr. Bomford, unlike many steam men, has not altered his former rotation, or increased the acreage of his root-crops; and bare fallow had been banished long before the engines made their appearance. But he speaks of a decided augmentation of yield per acre. He is "sure of better crops,"—which in itself expresses a great deal, when uncertainty is one great element in a clay-land farmer's misfortunes. "There is no comparison," he declared to us, "between the steam and horse systems," in respect to produce; he gets a more uniform sample of grain, and, moreover, considers that harvest comes earlier than before. Judging by the stubbles, we believe that he grows very heavy and good wheat-crops. He ploughs shallow for wheat, but finds that deep-grubbing of clover-lea in July pre-

* I calculate on getting my own lands smashed up by the middle of September, and being then ready for some remunerative contract work.—B. B.

pares a first-rate seed-bed for wheat. We saw a field of beans, part after ploughing, part after cultivating, both operations done by steam; the former much the better crop, and the land cleaner. The rotation on the heavy land is a 6-course. Stubbles, forked if requiring it, are smashed up and crossed for the fallow crops, mangolds, swedes, and rape. On four or five fields "kind for turnips" he takes two root-crops in succession, namely, mangolds, swedes, followed by wheat, and then beans. But Mr. Bomford farms like a gardener: he is not content with one good crop in a year. He grows vetches, and swedes afterwards, 14 tons to the acre—looking to his mangolds for great weight per acre. He has this year some of the best swedes we have seen, grown after rape. He showed us a superb piece of turnips grown between beans just removed; and another field of cabbages planted by gardeners between the rows of a pea-crop that had yielded 5 quarters an acre. We are not surprised, after such results, to hear Mr. Bomford say that he should be "very sorry to farm without steam." We may add here that we believe his machinery to be well managed; and the rope is properly tarred, &c., before being put away for winter.

Mr. Bomford's experience upon sundry other points is this:—Levelling high-backed lands by ploughing them down ruins the soil; but he is satisfied that, if you let the surface level itself, or "tumble down of its own accord" under the gradual wearing of steam grubbings repeated at long intervals, all will be right, and heavy land drain well with no necessity either to "ridge or cast." When a piece of levelled land is deeply tilled, the water escapes quicker; but if the surface be perfectly flat, the drains should be laid deeper, though no longer wanted so near together.

No. 70. The late Mr. James Marsh Read, of Elkstone, Cheltenham, Gloucestershire. Mr. Read, whose sad premature death has occurred since the date of our visit, was distinguished as a breeder of Herefords and Cotswold sheep, and for having introduced the steam-plough into one of the last regions where it might be expected to prosper. For the village of Elkstone is mounted on the lofty Cotswold district between Cheltenham and Cirencester, at some 1000 feet altitude above the level of the sea; and it is surprising that a steam-engine should be able to climb out of, or descend into, the deep valleys of the region by roads resembling mountain-passes. Yet here we found not a stationary engine "set," but a Fowler self-moving engine and 4-furrow plough, in a field of fine clover-lea, 1000 feet (as Mr. Read informed us) above the ocean level. This engine is of 10-horse power, of the "old make," fitted with a narrow rope-drum on the hind axletree, for hauling itself along the headland: and

it bore on its name-plate the inscription, "Kitson and Hewitson, No. 46, 1860." One tremendous hill that it had ascended, with a couple of horses assisting, has an incline of about 1 in 6 (as far as we could judge), and this not for a short rise, but (with occasionally pitches at a lower angle) for three-quarters of a mile up. Yet Mr. Read admitted no particular difficulty in moving the machinery about, and had not burned out any fire-boxes. The "road gear" has broken once, but now stands well; and while no particulars were given to us (Mr. Read's painful ill-health preventing him from working out the details of repairs from his accurately-preserved record of breakages, and time and cost expended upon steam tillage), we believe that the items of expense have been mainly for the ordinary renewal of rope-shares, &c. One little "extra" in working on these hills is that the water-cart requires two horses; and the cost of coal is 20*s.* per ton. An idea of the peculiar conditions under which steam-power has to cultivate here will be gathered from the nature of one of Mr. Read's large fields stretching from the bottom of a deep valley or gorge, with a very steep slope (1 in 6 for most of the distance), to the brow of a hill we should think several hundreds of feet higher than the other end of the field. The soil at bottom is blue-lias clay; at top, fuller's-earth clay, with inferior oolite-rock making a thin soil along the face of the slope, the surface of which is completely covered with small (and some big) stones. The engine traverses the headland at bottom, and the anchorage works its way along the summit of the escarpment. The plough takes three furrows up and four down; but the cultivator will not work at all, from over-balancing itself. Few localities could be chosen naturally less adapted for steam culture than this steep farm, part of thin brash with land-fast stones, and part of very heavy fuller's-earth clay some 50 feet in thickness. The climate, too, is very inclement for grain-crops on account of the excessive rainfall—often producing a large quantity of straw with a small yield of grain; yet, being in the south-western quarter of England, the peculiar mildness of the temperature here, promotes the growth of weeds and of timber, beech and whitethorn both flourishing in this elevated situation. We saw wheat-sowing in progress, 700 feet above the sea; and Mr. Read informed us that barleys commonly give about 32 bushels per acre, but not of good quality. The barley crops that we saw were very short and thin; the turnips planted in July were miserably small; mangolds are grown about every seventh year. On 740 acres arable (besides 296 of pasture and plantation) a modified 4-field rotation was pursued; and used to keep 16 horses and 30 oxen at work. The steam-engine has banished the bullocks, with the great advantage of being able to get over

three times as much tillage per week when wanted, saving of time being an extraordinary benefit at such an elevation as this, where the weather is almost always wet (so much so that, during the whole month of September, 1866, there occurred but one day without rain, and the fall amounted to about 8½ inches. A peculiarity in the culture here is that the clover-lea, when ploughed, is crossed either by horse-drags or by the steam-cultivator, the fuller's-earth being so unkind. The steam-ploughing on this clay is done 4, 6, and for some purposes, 9 inches deep, and is found greatly to improve the drainage and drying of the land.

No. 71. Mr. J. Higginbottom, of Pensax Court, Tenbury, Worcestershire, has a Howard's tackle, with 5-feet cultivator and steam-harrows, driven by a Robey and Co.'s 10-horse engine. The whole was bought, in 1863, for 900*l.*; and the repairs since have cost about 90*l.*, inclusive of 40*l.* for rope. With more care in working, the repairs would be less. The farm, principally stiff land resting on clay, but partly light soil with sandy subsoil, includes 420 acres arable and 680 pasture and orchard. The fields are of only 12 acres average size, and very hilly. The grubber does about 6 acres a day; the engine consuming half a ton of coal, at 8*s.* per ton; coals being found on the estate and fetched by the horse that carts the 5 or 7 hogsheads of water for the engine. Five men and four boys work the tackle; total wages 16*s.* per day. A shift occupies three horses for five hours. The engine is used for driving a saw-mill, grinding-mill, and chaff-cutter. Mr. Higginbottom observes an improvement in the drainage; he has increased his area of root-crops, and his crops generally have been made more productive.* There are now only 9 horses kept upon the farm.

No. 72. Mr. John E. Stanier, of Uppington, Wellington, Shropshire. In the vale overlooked by the Wrekin, Mr. Stanier occupies 220 acres of arable, and 60 acres of pasture; all tolerably level, and in fields of 25 acres each (two being of 50 acres each) made by grubbing up 2½ miles' length of fences. The soil is a strong loam and part clay, chiefly upon a clay subsoil. On this comparatively small occupation he has ventured to adopt steam cultivation; in March, 1864, he purchased a Howard tackle, with 3 and 5-tine cultivator and 3-furrow plough, and a 10-horse portable engine by Barrows and Carmichael, for a total of 690*l.* Additions have cost 5*l.*; and repairs 20*l.*, with

* A good portion of the land was turned up in the autumn and afterwards thrown up into ridges, the ridging-body being fixed upon one side of the cultivator and the subsoiler on the other; so that from the top of the ridge to the bottom of the subsoiler the land was stirred to a depth of 18 inches. The result is, that very stiff land is a fine tilth, and with one good stirring, fit to receive the barley-seed. —J. H.

ordinary wear of rope, porters, &c. Coal, at 11*s.* per ton delivered, costs 3*s.* 4*d.* per day; oil, about 1*s.* 6*d.*; water, about 750 gallons, is drawn by horse and man from a water-work pipe. Six men and two boys are paid 13*s.* 6*d.* a day. And to shift takes 6 horses for 2 hours, if in the same or on an adjoining field. The quantity ploughed per day is 6 acres; and cultivated, 6 acres with the 3-tined, and 10 acres with the 5-tined cultivator.

The engine is employed 45 days on this farm, exclusive of delays from bad weather or from breakages, both of which have been very trifling. The engine also thrashes, pulps, grinds, and is let out to thrash for hire. In the spring of 1864 it cultivated 300 acres for neighbours, at 7*s.* to 10*s.* per acre; but the tillage is at present confined to this farm.

Mr. Stanier has dispensed with 4 out of 10 horses, and thinks he saves half the horse-corn on these. He considers that steam cultivation assists the natural drainage of land, and has this winter profitably fed off turnips with sheep. He says, "My crops have increased so much as to excite the surprise of every one, and I consider the increased productiveness of the land entirely due to greater depth of cultivation obtained by steam power. Though, in my own case, the original outlay was great, and my farm a small one, I consider myself amply repaid in increased crops, greater depth of tillage, as well as cheapness and efficiency of work. Even the most sceptical of my neighbours now no longer doubts the numerous advantages of steam over horse power." He further writes of the great value of Howard's steam-harrows, which do 20 to 25 acres per day.

No. 73. Mr. H. Reginald Corbet, of Adderley, Market Drayton, Shropshire, purchased a Fowler 12-horse engine, anchor, 4-furrow plough, and 7-tined cultivator, in February, 1861. The cost was 777*l.*; with additions, 75*l.*, making altogether 852*l.* Many of the castings were too weak, and had to be replaced. The repairs have amounted to 144*l.* 1*s.* 3*d.*; the weakness of the "drums" necessitated their replacement by new ones; the caps and eyes of the rope were too small, and constantly breaking. But since heavier eyes, &c., of an improved make have been used, the whole have stood well. Mr. Corbet's farm consists of 400 acres, of which only 140 acres are arable—this hilly, and in one large field of 100 acres, with other small fields; the large inclosure having been obtained by knocking down old fences. Grass headlands are left for the engine to travel on, and "anchor blocks" are laid down at intervals of 100 yards. The soil is a strong loam upon stiff clay. The engine ploughs on an average 4 acres per day, digs about the same, or cultivates up to 14 acres in a day. Water is supplied from a pit at the top of the farm, and from a brook below. Coal costs there 12*s.* per ton. Wages

are,—engine-driver, 1*l.* per week, and house to live in; he is employed at other times in a carpenter's shop; the ploughman has 14*s.*; the anchor-man 12*s.*; two porter-men 12*s.* each; and waterman 11*s.* per week. Removal takes two horses for half an hour, but the whole shift occupying half a day. The engine is employed three days a week in sawing, in grinding, and working other farm machinery.

Mr. Corbet says that the drainage is improved, but he does not attempt eating off roots on strong land; his course of cropping has been altered, not by increasing, but by decreasing his breadth of roots, and growing two corn crops in succession; and the yield is certainly increased, though, "having taken the land from a tenant, cannot say in what ratio." This tenant used to keep 8 horses; Mr. Corbet added 300 acres, and employs 7, but they do estate work besides.

No. 74. Mr. Thomas Nock, of Sutton Maddock, Shiffnal, Shropshire, occupies 500 acres arable and 50 of pasture, in generally level fields from 9 to 16 acres in extent ("many fences taken up, and more should be"). The soil varying from strong loam with clay subsoil on most part, to red sandstone on the remainder. In April, 1862, he purchased a Howard tackle with 10-horse engine, costing 500*l.* It cultivates 5 up to 10 acres per day, according to depth. Coals are burned at the rate of 12 cwt. per day, costing 10*s.* per ton. Water is supplied by horse and cart; five men are paid 2*s.* 6*d.* each per day, and three boys 1*s.* each; and taking up and setting down the apparatus (besides travelling) takes 2 hours. The engine does the farm thrashing. Mr. Nock says that the drainage is certainly improved; and also that the root-crops can be fed off with much more advantage. He has not altered his rotation of cropping. His team force is reduced from 18 horses "before" to 15 "now."

No. 75. Mr. Henry Hanbury Tracy, of Gregynog Hall, Newtown, Montgomeryshire, works a Howard tackle, with [illegible]-tined cultivator and ridging body, a heavy steam-harrow, light harrow, and side harrow, by a 10-horse portable engine, upon only 106 acres arable. The soil is a "mixed heavy loam, hard and tenacious," "hilly," and now divided into seven fields, ranging from 7 to 30 acres—all altered to suit steam cultivation—and roads have been made for bringing the engine to each "station," while at each "station" a reservoir has been constructed, so that the engine pumps its own water. The repairs have been "5*l.* or [illegible]" chiefly from breakages. The average performance is about [illegible] acres cultivated per day. A removal takes 6 horses, "on the [illegible]age," "from a day to a day and a half." When taken in hand, this farm was in "a most wretched, neglected state:" [illegible] horses will now do all the work required [except the re-

movals !]; but it would take three times the number to do what we now do by steam." Much of the ground having produced nothing before, except gorse, thistles, and rushes, it is impossible to assign any increase of production to the steam work.

No. 76. Mr. Vincent Gosford, of Tanylan, Holywell, Flintshire. In May, 1861, Mr. Gosford began steam cultivation with a set of Howard's tackle, including a cultivator, a 3-furrow plough, with two extra bodies for deep work, a single plough for very deep work, and heavy steam-harrows, driven by a 10-horse engine. The cost price was 672*l.* Wearing parts and fittings have cost 25*l.* 10*s.* 6*d.*; alteration of cultivator, 12*s.*; and small repairs, done at home, not exceeding 5*l.* In 1865 a new rope was supplied.

The farm comprises 414 acres arable and 100 grass,—three-fourths of it a deep alluvial soil,—the rest lighter. It lies perfectly level, in square inclosures averaging 20 to 30 acres each, intersected by four straight water-cuts for the drainage, these being very convenient for feeding the engine.

The engine—consuming on an average half-a-ton per day, at 12*s.* 3*d.* per ton on the ground, with a boy supplying water by a pail—ploughs 5 acres a day, or, with the deep plough, 15 inches deep, 3 acres; or cultivates with the 3-tiner, 6 acres, and with the 5-tiner, 8 acres per day. With the harrows, it does, once over, about 16 acres per day. The engine-man (the farm blacksmith) has 2*s.* 6*d*; windlass-man, ploughman, and two anchor-men, 2*s.* 2*d.* each; two porter-boys, 1*s.* each; and the water-boy, 8*d.*; total wages, 13*s.* 10*d.* per day. Four horses move the tackle in 2 hours, on an average, "ready to start." The engine does the farm thrashing. Mr. Gosford has diminished his number of horses from 20 or more to 12 now.

He says that the drainage is "unquestionably" improved. "After the deep ploughing the rain-water quickly disappears, and the land is ready much sooner for the implements. After the old shallow ploughings the small hollows silt up and hold water like basins for weeks. On this flat soil the land, after *cultivating*, was washed down so closely that the work had frequently to be repeated, whilst the best possible seed-bed is left after the deep ploughing." The plough was not purchased for the first two seasons. He has altered his rotation by much enlarging the area of root-crops, "as we can now successfully grow root-crops on the strongest land." As to increased productiveness, he writes, "I have no hesitation in saying that the farm is in course of progressive improvement, entirely attributable to steam cultivation."

The following are a few collected particulars from farms in this Division:—

[illegible] No. of the Farm.	Acres Arable.	Nature of Soil.	Apparatus.	Horse-power of Engine.	Acres Ploughed per Day.	Total Cost per Acre.	Acres Cultivated per Day.	Total Cost per Acre.	Total Yearly Cost of Steam Tillage.	Reduction in Number of Horses.	Number of Horses now kept to each 100 Acres.
65	100	Strong clay ..	Howard	12	3½	..	4¼	..	..	..	4
66	367	Clay..	Fowler..	12	5 to 7	..	7 to 10	..	£251	20 to 10	3
67	430	Clay and light	Smith, Howard, and Fowler ..	10	..	..	4 to 6	6*s.* 7*d.* to 8*s.* 10*s.*	£168	22 to 16	3¾
68	730	Clay..	Howard and Fowler	12	3½	..	7	..	..	38 to 18	2¾
69	900	Clay and loam	Savory and Fowler	Two 12	6 to 10	7*s.* 6*d.* to 13*s.*	8 to 12	6*s.* 6*d.* to 9*s.* 7*d.*	£385	45 to 20	2¼
70	740	Clay and brash	Fowler	10	..	..	..	..	..	Saves 30 oxen	2¼
71	420	Clay and light	Howard	10	..	..	8	..	..	24 to 15	3¼
72	220	Strong loam and clay	Howard	10	6	..	6 to 10	..	..	10 to 6	2⅔
73	140	Strong loam ..	Fowler	12	4	..	14	..	..	..	..
74	500	Strong loam and red sandstone	Howard	10	..	..	5 to 10	..	..	18 to 15	3
75	106	Heavy, hilly ..	Howard	10	..	..	6	..	..	..	3¾
76	414	Strong alluvial	Howard	10	5	..	6 to 8	..	..	20 to 10	2⅓

Division 3.—South.

No. 77. Mr. J. Allin Williams, of Baydon, Wiltshire, has "had the honour" of spending not only several but very many thousands of pounds in breaking the steam-horse to field-work. Indeed, he was the earliest practical experimenter in steam-power husbandry; so devoted to the cause that he turned his malt-house and some other buildings into a regular farmyard foundry, in which he melted iron and brass, and (as he himself told us) "worked with chisel and file, till neighbours had left their farms without his knowing it." Unfortunately, however, Mr. Williams, clever and sanguine as he is, did not succeed in making more than two of his several patented inventions of ultimate practical value; and, beyond the small royalty which he receives from these, which he assigned to the late Mr. John Fowler, and the improved facilities now presented by his farm for the operations of steam culture, he has had no return for a great deal of property sunk in the pioneering of a great enterprise which other men have carried to a triumphant issue. It is not for us to say how far Mr. Williams' early efforts were guided by sound judgment; but we do know that, by the interest they excited, a powerful impetus was given to the whole question of steam tillage.

The farm comprises 274 acres arable and 16 of grass—the greater part, a very strong tenacious clay, in spots upon a chalk subsoil, in other places 20 to 50 feet in depth, and without springs—being naturally drained by the underlying chalk, and so requiring little or no underdrainage, provided the staple is not allowed to "pan." The surface is in part level, and partly presenting very steep acclivities; in fact, this is a lofty situation on the Downs, at an altitude of 900 feet above the sea-level, and in the vicinity of King Alfred's hill-stronghold the classic "White Horse." The fields average about 17 acres in size; the boundaries and headlands having been altered expressly for steam cultivation, so as to get them as square and paralleled-sided as possible, and avoid acute-angled corners—called here "pickids"—in other places "gores" or "skewtings." A good deal of this has been effected by exchanges of dispersed lands made with abutting proprietors; but some of Mr. Williams' neighbours have not yet agreed to meet him in nothing but straight lines. These exchanges cost Mr. Williams 50*l.* He has filled-in no fewer than 17 chalk-pits, that the plough and cultivator might go through them, and has excavated 3 field-tanks. We looked into one of these: it is of 6 feet diameter and 13 feet deep, in a situation where no water could be got except from a distance; and it is supplied from the roads, and by a few drains from the surface-

water of the adjacent fields. When emptied by the engine, it is sure to be filled again at the next rainfall; and the cost of digging, laying the bricks, and of the 1500 bricks, was 5*l.* 12*s.* 3*d.* In his pamphlet, 'Progressive Agriculture' (published in 1858), Mr. Williams well remarks how superior is a tank to a pond: occupying scarcely any ground space, preserving the water from evaporation, being safe from the injuries of frost or dry weather (so ruinous to ponds if not full), and costing three-fourths less in proportion to volume of water contained. And he describes a simple but very ingenious method for moulding dove-tail bricks to form the barrel-arch of a tank or well of any given diameter. The importance of plentiful supplies of field-water is noticed in several parts of our Report; and indeed, in many localities, the steam-engine and the water-drill, together, really demand this provision of drink before they can go to work without an unreasonable expenditure in water-carting. Mr. Williams made short work with his obnoxious hedge-rows and field timber, and curiously enough, he used to affix grub-hooks and chains round old hedge roots, and by a slow-motion roller on his ploughing engine, tear them out of the ground, 7 or 8 stout roots at a time. The same operation he applied to big trees; opening the soil on one side for a fall, cutting off a few of the lateral roots, and then pulling a tree down bodily by a chain connecting the top with the engine—which with its roller hauled with the force of 70 horses. It is surprising, also, what long steep hill-roads Mr. Williams' engines traverse with little difficulty. They have had no difficulty or mess with the engines on wet or soft land. If the wheels begin to "skid," they are not allowed to "burrow like rabbits;" but the engine is stopped, and stones picked off the land are put in the holes before the wheels, or else pieces of wood which are carried along with the engine for this purpose.

Mr. Williams has an 8-horse engine and a 6-horse engine of his own design; in fact, his old engines, which were exhibited at the Salisbury Meeting of the Society, and also a 12-horse Fowler engine and anchorage set, which we saw at work. This engine (manufactured by Smith of Coven) is of the now antiquated make, with a number of V-groove drums instead of a single clip-drum, and (as Mr. Williams said) does "shockingly bad" by his rope. A Fowler 4-furrow plough was making extremely good work, at a cost, we were told, of about 9*s.* per acre. It would [illegible] horses with the gallows plough of the county, to turn over an acre in a day at the same depth; the custom of the neighbourhood, however, is to plough shallow, with 3 horses. The [illegible] implements used are a 9-tined cultivator, of 7 feet width, constructed by Mr. Williams, with the tines "in three's" upon three lever-frames which rise and fall like the coulters of a drill;

also a lever drill-presser, each press-wheel rising and falling at liberty from the others ; and a massive apparatus of rollers, drags, and harrows, which is steered by diverting the rope to the right or left of the central line of draught. We observed that Mr. Williams uses Aveling and Porter's travelling rope-carriers along the implement track, of which he speaks very highly.

The acreage ploughed per day is 5 to 6 acres; or cultivated, 10 to 12 acres. Coal is dear, 25*s.* per ton delivered, and about 9 cwts. are consumed per day. Oil costs 1*s.* The water-carting takes 1 horse; but when a tank is near, this horse is engaged half his time in harrowing, as he has only about 450 gallons to draw. The engine travels, with 1 horse to steer, and takes everything along with it; and, with laying out the rope, anchor, &c., 2 horses are required, from 2 to 4 hours. The labour costs engine-man 3*s.*, ploughman 2*s.*, and 4 men or stout boys at 1*s.* 6*d.* each. All the heavy tillage of the farm is done by this tackle, of which the following are the particulars—from January 1st to Nov. 6th, 1866, 194 acres ploughed, 100 acres grubbed, and 20 acres rolled, dragged, &c.; and there remained to be ploughed before January 1st, 1867, 96 acres, making a total of 410 acres in the year's work. The apparatus occasionally goes out to contract work. The following are examples. Four fields (about 40 acres) were ploughed for 16*s.* an acre, or 31*l.* 18*s.* 3*d.* The expenses for 10 days' labour, including removals, which were frequent, and oil, were 8*l.* 14*s.* Again, about 40 acres were ploughed for Mr. Campbell, of Buscot Park, some at 15*s.*, some at 20*s.* per acre (with coal and water), coming to 34*l.* 1*s.*; and the expenses for labour and oil, 14 days, were 12*l.* 4*d.*; repairs cost 3*l.* 5*s.*; leaving 18*l.* 15*s.* 8*d.* for the machinery. The work was very severe, the engine at 90 lbs. pressure, being only just able to drive 3 furrows, and the journey there and back was between 20 and 30 miles.

We noticed that Mr. Williams had housed his engine-man under a sort of roof over the engine foot-board, very well in hot summer weather, but bad for cutting draughts in windy weather; the sides could have doors, and lock up as a security for coal. The "set" was bought second-hand in March, 1862, for 350*l.*, and has cost since then 150*l.*, including rope, new fire-box, tubes, &c.; while the smaller repairs, executed by Mr. Williams' engine-man, amount to about 70*l.* in the whole.

As to results, 5 out of the 11 horses formerly kept, have been displaced. Then the drainage is improved; by which is meant that land formerly holding water on the surface for days, now lets it soak down as fast as the rain falls, and all the soil of the farm is much drier. The acreage of roots has been very little increased, and Mr. Williams says that, though the yield of his

crops is satisfactory, he finds a greater improvement in the quality of the produce, consequent upon the use of the steam-plough.

No. 78. Matthew Savidge, of Sarsden Lodge Farm, near Chipping Norton, Oxfordshire. Quite a nest of steam-ploughs is to be found on the estate now owned by Earl Ducie, and which was improved by the late Mr. Langston, M.P., till it became one of the finest examples in England of permanent land amelioration. At the Leeds Meeting, in 1861, Mr. Langston purchased a Fowler 14-horse engine and 4-furrowed plough, adding afterwards a 7-tined cultivator; and in March, 1864, after the death of Mr. Langston, Mr. Savidge bought the full set "second-hand" of Lord Ducie, for 600*l.* His report is that he has every reason to be satisfied with his bargain, and that all the farmers in his vicinity are well pleased with the Fowler form of tackle.*

What is the precise sum incurred by Mr. Savidge for wear and tear, allowing for important replacements always rendered necessary after a few years of heavy labour, it would not be right to publish in the case of a second-hand set. For though Mr. Savidge objects to travelling his machinery far upon roads, it occasionally goes out to contract work, at some 14*s.* an acre, and though the best working land seldom falls to the lot of the steamer, the earnings come in nicely to defray the coal-bill and the men's labour due to the tillage upon this farm; and there would be an end to fair and equal bargains between letter and hirer, if every bit of the risk and profit were publicly known to a T beforehand. One fact, however, we may mention, and most important it is: the Leeds rope, 5 years old, has worked 5000 acres, and the tillage as we shall presently describe, has been no playing with a few inches of surface-soil, but a profound searching into a difficult subsoil. Among other items of damage, the engine crank-shaft has been broken, and the use of bad water rendered necessary a new pump. But (besides the rope) the "clips" upon the hauling-drum wear well, when not too tightly pinching, and the small "repairs" have not amounted to 10*l.* a year. The daily working expenses are as follow:—The engine-man has 2*s.*; ploughman, 2*s.*; anchor-boy, 1*s.* 4*d.*; three porter-boys, 1*s.* each; and the water-cart man, 1*s.* 6*d.*, amounting to 9*s.* 10*d.*, to which must be added 1*s.* 2*d.* for a gallon of beer, making 11*s.* a day for labour. All these hands are agricultural labourers, assisting at other times in any work on the farm. The water-supply being plentiful and convenient, with a "portable

* During the three or four dry seasons I began to think we could cultivate our land with the grubber only, but last autumn has plainly told us we cannot do without the plough.—M. S.

pump" placed when required at the nearest available point, 1 horse is able to convey all the water and coal—costing say 2*s*. 6*d*. per day. Removal, if in the same inclosure, takes a couple of horses two hours; if to a considerable distance, it requires 5 horses, that is, 3 to haul the anchorage, and 2 to the plough. If a shift be requisite about every fourth day, the sum for this item will be less than 1*s*. upon each day's work. The oil costs 1*s*. Coal is generally burned at the rate of about 12 cwts. per day, at 15s. a ton, that is, 9*s*. worth in a day. The total of these several items is 22*s*. per day. The ordinary performance per day (including the time wasted in removals) is about 6 acres of ploughing, 7 acres of digging (with prong-breasts on the plough-skifes), or 9 to 10 acres of cultivating with the 7-tined implement; so that the working expenses are 3*s*. 8*d*. an acre for ploughing, 3*s*. 2*d*. an acre for digging, and 2*s*. 2*d*. to 2*s*. 6*d*. an acre for cultivating. In a fine time, these average quantities of work are exceeded, and they have "raced" 14 or 15 acres in a day, for which the working-expenses would be only 1*s*. 6*d*. or 1*s*. 7*d*. an acre. What must be put to these various prices for repairs, interest and depreciation, we cannot exactly say. The rope (from what has been stated above) would scarcely exceed 4*d*. an acre. The area steam-tilled on this farm in a year (that is, both first and second times over) is under 200 acres: may we guess the repairs at 1*s*. 8*d*. an acre? If this be anything near the truth, the whole working costs per acre will amount to 5*s*. 8*d*. for ploughing, 5*s*. 2*d*. for digging, and 4*s*. 6*d*., 4*s*. 2*d*., down to 3*s*. 6*d*. for cultivating. The engine does all the farm thrashing. If we allot a portion of the cost price to the thrashing account, and take interest at 5 per cent., on say 500*l*., and depreciation at 5 per cent. on the same sum *minus* the value of rope and other wearing parts, say on 400*l*., we shall have a yearly charge of 25*l*. for interest and 20*l*. for depreciation, or 45*l*. to be divided over the whole acreage done, say an average of 4*s*. 6*d*. an acre. But not knowing the relative quantities of the different sorts of work, or the number of days occupied in the year's tillage, we cannot say how much more than 4*s*. 6*d*. should be charged on each acre of ploughing and digging, and how much less than 4*s*. 6*d*. should be charged upon each acre of cultivating, though we believe that Mr. Savidge does three times more of grubbing and digging than he does of turnover ploughing. We may, however, fairly put the case in this general way: Mr. Savidge appears to us to execute the tillage of his farm (contract-working, in which other people must pay for accommodation and expedition as well as for mechanical efficiency, more than they would give for ordinary horse work, does not come into the same category with these home operations) at the above working figures per acre; while over

and above these outgoings he maintains the steam-horse for 45*l*. a year—just about what an extra real live horse would cost him. So that the second-hand steam-plough, while performing each operation with cheapness as compared with animal labour, involves no ruinous or even burdensome sinking of capital. Mr. Savidge admitted to us that the steam tillage certainly costs less than animal tillage did.

As to direct gain from the use of this economical apparatus, one item is very clear and convincing. Mr. Savidge now works 9 horses upon his farm, which consists of 380 acres of arable, and 180 acres of pasture; but before the engine came he ploughed with a gang of 12 oxen, or rather of 16 (with the spare bullocks), in addition to the 9 horses. All the former expenses connected with these 16 bullocks he now keeps in his pocket (or rather the money is available for something else); that is, at 15*l*. per ox (for which assumed cost of maintenance, *see* our Introduction), there is a saving of 240*l*., to be placed on the credit side of the steam account. On the debtor side stands the whole yearly cost of the steam tillage. Well, if the proportion of cultivating done be about three times that of the ploughing (as we think it is, though the exact figures have not been ascertained), the average cost per acre, including everything, cannot exceed 10*s*.; and upon 200 acres tilled in a year, the total outlay for steam-work on this farm will not be more than 100*l*. The balance is 140*l*.; or, in other words, Mr. Savidge's annual expenditure for the item of tillage-work must be something like 7*s*. 6*d*. an acre less over his entire farm (arable) than it was before the steam-machinery was substituted for oxen. We would remind readers here, that these calculations are not Mr. Savidge's, but ours; but we are confident that, though wanting in the correctness which only exactitude of every detail could give, the main results are borne out by the statements with which he kindly favoured us. Now, the saving of a few shillings per acre over a whole farm may not appear of any profound importance—though in many cases it just makes all the difference between getting "a comfortable crust with something laid by on the hob," and the miserable existence of barely "making both ends meet." However, a positive lessening, instead of an increasing of the former outgoings, is a grand point in an example of steam cultivation; farmers being too commonly so restricted in their command of capital that they are infinitely more ready to try a new system sure to curtail their old rate of disbursements, than one involving an additional investment with good hope of a profit. Mr. Savidge's case is so far encouraging; but a more momentous inquiry has to be made, whether he has not "bought his whistle too dear"—whether he does not lose by inferior produce or a heavier labour

bill, or any other result of the new husbandry, more than he saves by the superior economy of the tillage-work? A brief description of the farm and its management will furnish the reply.

The 380 acres of arable lies in large fields, averaging 30 to 40 acres each, with low fences and few trees. This is because it is part of a liberally-treated and highly improved estate, hedges having been abolished, and trees removed without mercy; and new hard straight roads formed where they were wanted. Thus Mr. Savidge is in a position where he can work his engine to advantage; whereas the absence of these facilities would have operated against him, and very probably have prevented his getting any advantage at all out of steam-ploughing. The soil varies from oolite clay to gravelly loam, 3 horses commonly ploughing 5 inches deep. The clay subsoil contains much lime, and, so far from being afraid to touch it, Mr. Savidge spreads on the surface the two bottom spits of clay out of under-drains, finding the effect to be like that of "claying" in the Fens. He has served an apprenticeship, as it were, with different sorts of steam implements upon this land; he greatly improved some of the implements in detail, and has the merit, we believe, of first applying the "digger-breasts" to the steam-plough. Some of the practical deductions from his experience are, that he may dip-in the cultivator tines to any depth, whereas very deep digging and ploughing should be done only at long intervals of time; and again, when land is to lie fallow through the winter it cannot be too rough, so that only for reducing clods to seed-bed, or for immediate cleansing of root-weeds, should the "drag-harrow" be used—that is, the heavy harrow worked by being slung alongside the plough or digger.

As an illustration of the management pursued, and of the use made of the steam-tackle, take a 40-acre field, of 10 to 14 inches of clay upon a substratum of gravel, with some higher undulation of gravelly loam staple. We saw in this field the stubble of a good wheat-crop grown after peas; the seed-bed prepared by twice grubbing the pea-stubble in July and August, 1865, and then, after it had laid awhile, harrowing the stale clods by horses just before drilling. For the pea-crop a wheat-stubble had been steam-dug 10 to 12 inches deep after harvest, left for the winter, and then simply harrowed and drilled in spring. The wheat of 1864 was put in thus—a bean-stubble was steam-grubbed 10 inches deep directly after harvest, and, after a time, harrowed and drilled-in by horses, Mr. Savidge not being at all afraid of 10-inch deep work for wheat, provided it be grubbing, and sufficient time allowed before sowing. The beans had been sown by horse-harrowing and drilling, in spring, a winter tilth

that had been steam-ploughed with furrows 6 to 8 inches deep. The previous crop of 1862 was barley, put in, *secundem artem*, by horse-work after swedes. These swedes of 1861 had been prepared for by two steam-grubbings (the second "across") in autumn, then manured in spring, and the manure steam-grubbed in; that is, thrice over with the steam-cultivator did all the heavy work required for fallowing and getting a clean, fine turnip-bed. The "artificial" drilled-in with the seed was 3 cwts. of superphosphate per acre, and the swedes were a fine crop. The farmyard dung and superphosphate for the swedes of 1861 were the sole manure applied to this field during all the succession of crops; yet after barley, beans, wheat, and peas, came a very fine yield of wheat in 1866, with, what we can vouch for, a particularly clean stubble. Mr. Savidge told us that this would be farmyard-manured, and the manure steam-ploughed-in for the pea crop of 1867. In fact, a new system of husbandry is being practised on this farm: the strong land of this oolite district is unkind for turnips, and neither the feeding-on nor carting-off of roots benefits such land (in fact, Mr. Savidge says that "a bit of turnips on a clay field spoils it"); and having a few fields of kind soil he is growing roots upon them *every third year*, but on the clay portions of his farm no roots at all. We have not space, in a *Report* embracing such a great number of farms, to draw the many obvious lessons from this fine example of a new system of management introduced by the steam-plough, but would call to it the special attention of our readers. The general result is, that having abolished dead-fallow, and changed the ordinary rotation on different parts of the farm, so as to suit the cropping to the capabilities of the two sorts of soil, Mr. Savidge grows a greater breadth both of corn and of roots, and also more summer-feed than he did before the advent of "steam." For instance, this very 40-acre piece, of which we have related the history, would have borne only a moderate crop of roots (with a good season) instead of a more remunerative crop of peas, in the year 1867, if there had been no steam-plough. While the main increase of production is found in more crops, there is also an augmentation of yield per acre, though to what extent is not clearly and easily perceptible until averages have been taken during a series of years. Mr. Savidge says that the crops are "more even," and their "quality better;" and his wheats after steam-culture have invariably been better and brighter in the straw. As a natural consequence of having more crops, and (we suppose) also more stock, the manual labour has been decidedly increased, but the artificial-manure account remains as before; and the great and good results accomplished on this farm are mainly due to the machine which, besides working the land more cheaply

than animals could do it, executes the tillage in a style of efficiency that they could not imitate at all.

The effects of the deep culture upon drainage have been exemplified on this farm in a way we should hardly have expected. The surface is slightly undulating, the "water-table" in the subsoil is low, the outfalls are good, and the average rainfall moderate, or 26 to 28 inches. Yet Mr. Savidge maintains that to lay any of his strong-land fields uniformly flat—that is, without any semblance of ridge and furrow—is a mistake. Probably he would say that an appeal to the example of a garden-bed is an inapplicable argument for the perfect drainage of deeply-delved horizontal ground; because, in the case of the garden, within a score yards or so, there are most likely ditches or other interruptions of a uniform plane. But whatever theory has to urge on the question, here is a practical proof: when a clover-lea on clay soil is grubbed-up early for what is here called a "pin-fallow" for wheat, Mr. Savidge considers himself obliged to plough it up into ridge and furrow before sowing, having found that it will not otherwise drain well through a wet season. Fields were laid flat, at the introduction of the steam-plough a few years ago, in the belief that good husbandry prescribed such a course; but it "did not act," because of the tops of the old ridges being too bad a soil, and the plough has now been used to cast them up again, though not very high. Mr. Savidge's declaration that he has damaged much heavy land by flattening it, probably finds a commentary and explanation in the experience of other managers who have done injury when they threw down high-backed lands in a summary manner, but not when the lowering was very gradually effected. Still, it may be true that certain descriptions of soil and subsoil require the superficies to be, as it were, slightly in "marcite" contour; on which question further information appears in our accounts of some other farms, —as, for instance, No. 67.

No. 79. Mr. Robert Craddock, of Lyncham, Chipping Norton, Oxfordshire, purchased a Fowler "10-horse set" at the Worcester Meeting in 1863, the total cost being about 780*l.* The only breakage of consequence has occurred to the engine-shaft, which cost 16*l.* to repair. The working charges are,—for labour, six men and boys, 9*s.* 6*d.* a day; removal, two hours of time; water, drawn by a horse and boy from tanks made in proper places on the farm; oil and grease, 1*s.* 10*d.* a day; coal, at 13*s.* per ton, from 12 to 14 cwts. per day. The plough does from 5 to 6 acres, and the cultivator 8 to 10 acres per day. The farm, of about 400 acres arable, and 130 acres of meadow and pasture, has a rather deep, retentive soil, with the subsoil of one part gravel, of another part clay. The surface is nearly level, and in

fields averaging about 22 acres in size, several old hedge-rows having been removed.

The engine is used for thrashing, grinding corn, chaff-cutting, and other operations; but the tackle is solely confined to the farm. Before the introduction of steam-power, 12 horses and 8 or 10 bullocks were worked; now the bullocks are dispensed with, and 8 or 9 horses "do the work easily."

Mr. Craddock says, "From deep cultivation we find the land lies much drier; as the water gets into the drains and runs off much quicker since steam-power has been adopted." He has increased the acreage of his root-crops, and reports that "the crops generally are more productive; the straw growing much stiffer, it is less liable to go down."

No. 80. Mr. Robert Hewer, of Fair Green, Chipping Norton, Oxfordshire, occupies 540 acres arable, and 200 acres pasture, partly "sour stone-brash," partly strong land; lying tolerably level, and in 20-acre fields, altered in figure to suit the steam-plough. He works a 10-horse set of Fowler tackle, formerly belonging to the late Mr. Langston, which was taken at a valuation for 400*l.* at Lady-day, 1864. The repairs have amounted to 25*l.*, chiefly for a new axle-tree to the hind-wheels of the engine, a new crank-shaft, &c.

The 3-furrow plough turns over 5 acres a day, and the 7-tined cultivator smashes up 10 acres a day. Coals cost 7*s.* a day, at 15*s.* per ton delivered; oil, 1*s.*; and water is carted by one horse from tanks. Removal requires three horses, on an average of distances, from three to four hours. Two men are paid 2*s.* each, and five lads 10*d.* each, making a total of 12*s.* 2*d.* per day for the manual labour: a low figure for weak hands, that we have found, in the majority of cases, to be an unadvisable piece of economy.

The engine is used for thrashing, and the apparatus confined to the farm.

Mr. Hewer gives no information as to results, beyond the fact that he has neither altered his course of cropping nor extended his usual breadth of roots. His team-force now is 12 horses.

No. 81. Mr. George Pocock, of Bourton, Shrivenham, Wiltshire. In October, 1859, Mr. Pocock, then occupying only 250 acres arable* (besides his rather large extent of pasture), ventured upon the purchase of a 10-horse Fowler engine and anchorage, and a 3-furrow plough, with 4th furrow skife to be attached when wanted. This is the old-pattern straight-beamed implement, with provision for adjusting the width of furrows, and is considered by Mr. Pocock to be stiffer in framing, and to stand to its work better than the newer bent-beam plough. We may

* ... more acres of arable were taken in 1861.—G. P.

observe here, that we found the coulters set considerably backwarder than the share-points, with a space about two fingers wide between the end of the coulter and the top of the share. This, according to the engine-driver "Charles," who is a prize ploughman, is the custom with horse-ploughs; the interval making way for small stones to escape wedging between the share and coulter, while tearing off a portion of the slice from the land-side makes the furrow turn better. But why are not the coulters on this plough—as is commonly the case upon steam-ploughs—kept relaid and sharp like the coulters on horse-ploughs? Mr. Pocock has exchanged the old groove-drums for a clip-drum, and the small rope-drum for the onward motion along the headland has been replaced by an endless pitch-chain and toothed-pinion, adjustable for tightening up the chain. In this, Mr. Pocock's own, contrivance the adjustment is effected somewhat differently to Messrs. Aveling and Porter's patent arrangement. The work which we saw in hand was being done by a home-made cultivator, partly after Mr. Pocock's own design, and partly upon the plan invented by Mr. Williams, of Baydon. Nine tines are carried by three lever-frames, which rise and fall like the coulter-levers of a drill; and the carriage-frame to which they are attached is fitted with two semicircular bows, or grooved sweeps, which support and hold off the tail-rope to either side alternately; this implement being made to turn round at each end of the field by means of the tail-rope pulling at one of these "bows." The action is very easy, and there is a barrel with ratchet for taking up "slack." The advantage, as compared with a balance-cultivator, is in the lightness of framing in proportion to the number of tines; in fact, a balance-cultivator may be said to consist of two cultivators set face to face. We understand that a question raised as to this method of turning being an infringement of the Woolston "turn-bow" patent, ended in Mr. Smith's presenting Mr. Pocock with a license. With the cultivator the average performance per day is 16 acres; that is, in cultivating land previously tilled; but generally it is steered so as to overlap half its own work, thus giving "two tines" to the field at one time, and so doing 8 acres per day. The 3-furrow plough, sometimes working a heavy drag-harrow alongside, averages 5 acres per day.

But in order that this work with a 10-horse engine may be appreciated, we must name the character of the land. It is a deep, solid, homogeneous clay, that used to take 3 horses to plough a furrow 3 inches deep, and 4 horses to plough a furrow 4 inches deep: the steam work, however, is done some inches deeper than either.

What is the cost? Ordinary labourers get 10*s.* a week. But

Mr. Pocock's engine-man has 18*s.* a week regularly, with 3*s.* a week more when steam-cultivating. The ploughman has 18*s.*, the anchor-man 9*s.*, and two porter-boys 7*s.* 6*d.* each. The water-cart lad has 6*s.* 6*d.* (5*s.* 6*d.*, G. P.); making the manual labour 11*s.* 7*d.* per day. The water-cart horse is put at 2*s.* 6*d.* (4*s.*, G. P.) Moving takes two hours; the engine self-travelling, but requiring a horse to steer,—an uncertain item, say 1*s.* 6*d.* upon each day's work. Coal, 8 cwts., at 14*s.* 9*d.* per ton, costs say 6*s.* per day, and oil, 1*s.* Thus the working expenses are 22*s.* 7*d.* per day; that is, 4*s.* 6*d.* an acre for the ploughing, and 1*s.* 5*d.* an acre for the grubbing once over. To this we must add the expense due to the machinery. About 600 yards' length of rope are in use at once, and 260 acres of ploughing, and 210 acres of scarifying and smashing up—making in all 470 acres of work per year—have worn out 1500 yards of rope in seven years; that is, the cost of 1500 yards of rope (*i. e.*, 150*l.*) is chargeable upon say 3000 acres of work done; or each yard of rope has been consumed upon about 2 acres of work, at a cost of about 1*s.* per acre. The rope is now in very good condition, a portion of it having only lately arrived from Leeds. The "repairs" have been about 20*l.* a year; or about 10*d.* per acre. Reckoning the interest and depreciation wholly upon the tillage-work, the interest at 5 per cent. on the prime cost, 750*l.*, will be 37*l.* 10*s.* a year, or 1*s.* 7*d.* per acre; and the depreciation, at 5 per cent. on say 640*l.*, will be 32*l.*, or 1*s.* 4*d.* per acre. Thus, the annual outgoings will be as follow:—

	£.	s.	d.
Working expenses:—			
Ploughing 260 acres, at 4*s.* 6*d.*	58	10	0
Cultivating 210 acres, at 1*s.* 5*d.*	14	17	6
	73	7	6
Rope, 214 yards per year, at 2*s.*	21	8	0
Repairs	20	0	0
Interest	37	10	0
Depreciation	32	0	0
Total cost of 470 acres tillage, at an average of 7*s.* 10*d.* per acre	184	5	6

But a deduction ought to be made from this account for the use of the engine in sawing, and, we believe, also in thrashing; the steam-plough engine having a considerable amount of such work to do, as well as the couple of 7-horse engines which Mr. Pocock keeps for contract-thrashing. We did not ascertain the number of days' work done by the plough-engine off the land; probably the above total outlay for steam tillage ought to be reduced 20*l.* or 30*l.*

M. [illegible] states that, in the absence of the steam-tackle, he

would require 12 horses more than he has now; and, at 44*l.* each, the saving is 528*l.* Subtract the total outgoing for steam tillage—say 160*l.*—and the clear gain by the substitution of steam for horses is 368*l.* a year. In the statement of the number of horses saved, we believe that Mr. Pocock, with his love of moderation, has estimated considerably below the mark; our own impression, when inquiring upon the spot, being that he saved 14 horses. If so, the clear gain will be 456*l.* a year on about 500 acres arable; a large result very much due to admirable management in making the apparatus do a great deal of work. No such profit would have been derived if the 260 acres of ploughing had been left undone, and the steam-work limited to the 210 acres of cultivation, which is about all the use that some farmers would have made of the tackle.

Mr. Pocock's arable is all heavy land, "very hard to work;" still it does not look hungry, and he explains that this is because the character of the staple has been materially altered by the absence of trampling and the deeper steam tillage. The strongest bits, he says, "are not like the same soil now." His system of culture is to take wheat every other year, as: (1) vetches with turnips after—at least on a part, (2) wheat, (3) beans, (4) wheat, (5) clover or seeds, (6) wheat; but this is not kept to invariably. We saw a magnificent crop of mixed peas and beans, probably 6 quarters per acre; and we were informed that better wheats and much better green-crops are grown since the adoption of steam tillage.

The land is drained 2 to 3 feet deep, and Mr. Pocock is well satisfied with having flattened his fields, so that not even water-furrows remain. He believes that all clays will drain well, if the levelling of the old high-backed ridges be done gradually; here, two or three years have been occupied in flattening them by the scarifier.

We believe the apparatus on Mr. Pocock's farms to be one of the most carefully managed that is to be found; but everything seems to be equally well looked after here,—including a herd of 150 to 155 cows; a dairy with three of Keevil's cheese-makers, a horse-power churn, capacious shallow tin milk-vats, and numerous presses; and also a saw-mill, where the steam-plough engine "earns a living" when shut out of the fields.

No. 82. Mr. Edmund Ruck, of Castle Hill Farm, near Cricklade, Wiltshire. What we learned from Mr. Ruck, one of the best known among the veterans of steam-ploughing, may very well be compressed into a short compass; seeing that his views and experience have been fully stated by himself to the Society's members (see 'Journal,' vol. xxiv., 1863), while a most interesting and scientific account of his improvement of grass-land

is given in the very last Part of the 'Journal' (New Series, vol. ii., 1866).

We could not forbear a diversion from our direct "steam" track to get a glimpse of the Manor Farm at Braydon,—lying in a low tract of poor clay-land, furze, water, and deep founderous lanes and "slogs," with pastures of "hardhead, rest-harrow, and devils'-scabious," a "water-table" only a few inches below the surface wherever it is not on the surface, and the unenviable notoriety that it "would rot a goose." Steam mole-draining 3 feet deep at every 2 yards, assisted by cross-drains at intervals of 4 chains, with only a few pipes at the outlets, and costing a little over 16*s.* an acre; lime-composting, liberal artificial manuring, and heavy sheep-folding on the grass have amazingly altered the nature of the herbage, and probably more than doubled the rental value of the land in four years. Mr. Ruck's very clever arrangement and economical construction of feeding and barn premises (particularly his faggot-roofing, his contrivances for watering the cattle in their boxes, and for distributing prepared food to about 50 bullocks by one man in less than five minutes), were matters of great interest to us; but for full information concerning this really extraordinary example of land improvement, we must refer readers to the above-named description in the 'Journal.'

Mr. Ruck's address to the Weekly Council, May 15th, 1863, relates how he purchased his 14-horse-power set of Fowler tackle in 1859, and at once sold off seven 4-ox teams: how he removed hedgerows and made sound headland roads: how he used Fowler's steam-draining plough without pipes: how his steam-ploughing (with drag attached), at the rate of 8 acres a day, cost him 5*s.* per acre; and scarifying (with drag attached), at the rate of 16 acres per day, cost him 2*s.* 6*d.* per acre: how the said ploughing was worth, by horses, 15*s.*; and the scarifying worth, by horses, 7*s.* 6*d.* an acre—the steam-work thus being executed at one-third the cost by horses: how a 14-horse engine does in one day the work of 30 horses: how heavy land drains much better and dries quicker after steam culture: how artificial manures operate more effectually, owing to the finer tilth produced: that digging by the steam-plough, at 5*s.* an acre, is really worth as much as spade-work done at 40*s.* an acre: that by autumn cultivation vetches and rye are grown and fed off in spring, in time for a root-crop to follow, by which the flock of sheep is greatly enlarged: that the harvest comes a week or ten days earlier: that the samples both of wheat and barley are better and heavier: that the seeds are wonderfully better: that clover can be grown after steam tillage every three or four years: that 8 horses are found sufficient to cart the corn on 600 acres arable; that the

improvement of the condition and status of the labourer is very great:—These, and a number of other points in Mr. Ruck's experience, having been already published, leave us comparatively little to say; but what we saw and heard may, nevertheless, be of considerable importance.

Castle Hill Farm consists of 620 acres arable, and 100 acres of grass. It formerly lay in 36 fields, but by destroying nearly 5 miles' length of old fences, it is now in 9 fields of about 70 acres each, having straight boundaries and very little timber. Four of these fields have a good loamy soil, managed on the 4-course shift; the other 5 fields have a calcareous clay and strong loam soil, growing vetches, rye, and other sheep-keep, followed by wheat, then clover, broken-up for beans (manured), and then wheat again. The draft-labour used to be performed by 9 horses in 3-horse teams, and 56 oxen worked in seven 4-ox teams, 28 in the morning, and the other half in the afternoon. These bullocks, bought as 2-year-olds and sold out as 4-years-old, improved themselves in value about 50*s.* each; grazing 100 acres of moderate pasture, and doing only summer-work,—Mr. Ruck arguing that they paid the rent of the land they fed on, giving their tillage-labour into the bargain. However, there was, at any rate, the cost of their harness, implements, manual labour for working them from 30 to 40 weeks, and feeding them during winter, besides the interest of capital locked up in them; and 7 teams, or 28 oxen, at say 15*l.* a year each, would involve an annual outlay of 420*l.* But without entering into a discussion of this question, we may merely say that, had there been no oxen, the same work would probably have required 14 horses; and these, at our standard figure of 44*l.* each, for everything connected with their maintenance and working, would have cost 616*l.*

We do not pretend to settle here whether it is 420*l.* or 616*l.* that Mr. Ruck saves every year by the banishment of his "horned horses;" but we are very sure that it must be a handsome sum, seeing that a great acreage of heavy ploughing and dragging is not likely to be done *gratis* by any animal or other motive-power, until "perpetual motion" turns out an accomplished fact. At present, Mr. Ruck has 10 horses, and (as he told us he did not mind being "a little pulled to pieces") we may add that they are in poor condition. He admits that he is longer about carrying his harvest than most people are; but the farm always has had about a hundred hands out of Cricklade, to cut the corn. The reaping is thus done very quickly, and the 10 horses, with 1-horse carts, stack a large part of the crops in the fields.

At the date of our visit (November 9th), he had done very

little autumn cultivation; but he had ploughed 600 acres since the 1st of May, and all his wheat-sowing was finished. In 1865, not a single acre of the ploughing was done by horses. We noticed a little couch on one of the headlands, and the explanation of this given us was, that the headlands are worked by horses and not by the steam-plough. After all the wheat is in, the clover-leas are steam-ploughed for beans, which are sown on the stale furrow.

The apparatus now used is a double-engine 14-horse Fowler set. Mr. Ruck tried the roundabout, the clip-drum single-engine and anchorage, and now declares himself warmly in favour of the two-engine system. The travelling-anchorage, he thinks wrong under any circumstances, for now he can finish up in one field and begin the next in about 10 minutes, which saving of precious time is worth anything on a large farm. Three men work the tackle, Mr. Ruck paying the engine-men 1*l.* a-week each (ordinary wages being 10*s.* a week, or rather averaging about 13*s.* a week the year through); and his hands being good fellows, and treating him and his machinery well, he does not care to begin piece-work. The average day's ploughing with one engine used to be 8 acres; with two engines it is 10 acres a day. We picked up a good notion from Mr. Ruck as to getting water from the field-wells or elsewhere: place the pump-barrel so low that the "bucket" is under the water-level, and you find the pumping so much easier that a boy can do the "water-work" of a man.

Mr. Ruck can never be persuaded to go back to the old slow horse-system, with all its trouble and its scamping of work; and (as he exclaims, with characteristic expression) "What a life the poor fellows used to lead!" He could never think of lowering his men again to the level of followers at the plough-tail. He has done some little steam-work for other people; but can seldom spare the tackle for the purpose, and his opinion is that for small farms the hiring system is much better adapted than the doubtfully feasible partnership of three or four farmers in an apparatus.

We do not know what is the total yearly expenditure here upon steam cultivation; it may be considerably more than the sum saved by displacement of teams, but the following items of advantage will be readily appreciated:—Mr. Ruck (like Mr. Hemsley No. 62) said that he found he could do the work of a horse with 6*d.* worth of coal. As to effects upon the farm, the arable soil, formerly 5 inches in depth, is now 7 or 8 inches deep; a considerably increased head of stock is kept, owing to the larger production of green keeping and roots, as well as to the absence of the working bullocks; and, what is very remarkable, Mr. Ruck declares that, by the use of the steam-plough,

he has improved his grain-cropping at least one imperial quarter (8 bushels) per acre. Large as this result is, it agrees with the estimate of Mr. Holland, M.P., of Dumbleton Hall (*see* No. 66), and some other adopters of steam cultivation.

An excessively wet season, in a district where the annual rainfall is about 26 inches, does not seem to tell against laying land perfectly flat, though some fears were entertained for the most heavy and sticky clays. There are no springs, and, with the general surface undulating slightly, the opened water-furrows are capable of preserving the ground from standing water.

No. 83. Mr. T. Pearce Brown, of Burderop, near Swindon, Wiltshire. We were not fortunate enough to find Mr. Brown at home, so that for what information we obtained his men and our own eyesight must be responsible. Burderop, 6 miles south of Swindon, is situated upon the line of Lower-greensand hill which rises out of the Kimmeridge clay valley in front of the lofty range of chalk Downs. The farm, of 1000 acres, comprises about 600 acres of arable, a strong adhesive calcareous loam, 1 or 2 feet deep, resting upon loose, chalky rubble, with about 3 feet depth to the solid chalk rock. It requires no under-drainage; and the land, lying in very spacious rectangular inclosures, with neatly-kept fences and scanty timber, is always ploughed flat. The practice was for 3 horses to turn a furrow 5 inches deep.

Mr. Brown has another farm of about similar size, but of more flinty character, at Baydon; but we believe that the principal use of steam culture has been here, the apparatus being a Fowler 12-horse set, with anchorage and clip-drum, bought in 1861. In that year it ploughed more than 840 acres; the next year, bringing a wet season, it ploughed and scarified only 530 acres. The most tangible and immediate result was the banishment of three teams, or 12 oxen, the present team-force being 14 horses.* The 4-furrow steam-plough, in a wet time or working in short lengths, does 4 acres a day; at other times, however, 8 or 10 acres a day; and it has done as much as 11 acres in a day. The work is often 10 or 12 inches deep; sometimes done with the smooth mould-boards, sometimes with the digging-breasts; and they have a drag-harrow to work alongside the plough. Occasionally they have ploughed 8 or 9 inches deep for wheat; and the drill has followed while they were at this deep work; but this does not answer after seeds. Some of the land is bare-fallowed; but for a fallow-crop, the ground is dug up shallow in the autumn and crossed more deeply in March.

* These oxen have since been restored, as in very wet seasons the steam-plough cannot be used to advantage. It is a fine-weather implement, and cannot always get through enough work for this soil, which is highly benefited by the sun and wind.—T. P. B.

The swedes that we saw were a remarkably fine crop, and the stubbles for the most part strong and tolerably clean. We were told that much better crops have been obtained "after steam," particularly a better yield of wheat, from the absence of treading. Wherever part of a field has been left for horses to plough (in consequence of the rope failing to compass the length of some of these big fields), that part can be seen for years afterwards, by its cropping being inferior to that on the steam-ploughed portion.

The apparatus can be squared-up ready for travelling in half-an-hour; the rope-reel beneath the clip-drum, saving much time in winding up the rope; and the engine travels without any trouble, the chief accident having been that the brake-wheel once broke. They have broken plough-skifes with the big stones during the first year's work, but do not expect this sort of thing now the land-fast stones have been found and taken out. They had one rope of very bad quality, for which Messrs. Fowler made them a present of a new one; this has been worn out, and the present rope is in good condition and but little worn. We observed that the plough-coulters are much worn and rounded off at the ends, and both coulters and shares badly "set," cutting furrows of unequal size; but good work can hardly be expected unless the "irons" of a steam-plough are as carefully attended to as those of a horse implement.

Two men and three (sometimes four) boys work the tackle; and while ordinary wages here are 10*s.* a week, the engine-man and ploughman are paid 18*s.* each; the anchor-lad, 9*s.*; the porter-boys, 7*s.* each. The engine burns about 15 cwts. of coal per day.

These details are very scanty, but we believe that Mr. Brown is satisfied with his investment, though we were unable to hear from his own lips that in case the steam-plough were to take sudden flight, he would certainly buy another.

No. 84. Mr. J. Stratton, of Salthrope, Swindon, Wiltshire, has a 12-horse Fowler set, purchased, we believe, in 1859; and alterations (or modernisation) since that time, with a new plough and cultivator, have cost about 300*l.* more than the original outlay. The farms (Salthrope and Broad Hinton) include 1000 acres arable, (besides 700 acres of pasture and 70 acres of Down,) having a very heavy adhesive soil upon a chalk subsoil; and the fields, varying from 50 to 200 acres in area, are generally level. No new roads have been laid out, but the headlands have been altered for the steam-engine. Mr. Stratton pays 12*s.* per day to the three men and three boys who work the apparatus; one horse and cart can fetch the water, for a distance of one mile; removal for a mile occupies 4 hours; oil costs about 1*s.* 3*d.*, and coal 10*s.* per day, at 20*s.* per ton. The area ploughed or dug is 5 to 10 acres, or from 10 up to 20 acres broken up with the cultivator. The engine is employed for 30 to 40 days in the year in thrashing.

The results are thus given :—Drainage is rendered more effectual, but not to such an extent as to make heavy land dry enough for sheep to eat off roots in winter; and Mr. Stratton is enabled to crop oftener and in better season, of which the gain will be very apparent to any practical man. But the steam-engine displaced 20 oxen and 3 horses, which used to involve a yearly outlay of probably 450*l.* to 500*l.*; and yet this engine is considered of more value than 30 horses in its capability for executing a great deal of work per day or per week, to say nothing about the quality, depth, and lightness of the tillage done.

No. 85. Mr. Georges Barnes, agent for Mrs. S. C. Hawkins, of Alton Pancras, Dorchester, has a Howard tackle, working a cultivator, side drag-harrow, and large drag, with a 10-horse engine. In 1862, the whole cost over 600*l.*, — a new cultivator since added bringing the investment up to 625*l.* The repairs have been accomplished by the farm smith. The farm embraces 700 acres of arable, and more than 700 acres of pasture; the soil, clay, chalk, with different subsoils, and very hilly and flinty. The fields vary from 9 to 84 acres: little alteration having been made in preparation for steam work. From 5 to 9 acres are cultivated in a day, with a consumption of about 1¼ cwt. of coal per acre. Water is brought from made ponds by horse and water-barrel. To move the machinery takes 10 horses, and half a day's time. The engine is used for thrashing.

Mr. Barnes finds the drainage quickened; he has increased the area of his root-crops; and says, "in 1864, the season was very dry, and roots generally very bad; theirs was a fair crop, caused, he thinks, by the land being prepared early in the season by steam cultivator." They formerly worked 32 horses, but since the cultivation began only 22 horses are kept.

No. 86. Mr. Henry Parsons, of Haselbury, Crewkerne, Somersetshire. On 1700 acres of tolerably level land,—for the most part heavy clay,—has a Fowler tackle, with 12-horse engine and anchor, plough, and cultivator. It was purchased in 1860; and since then, two new ropes have cost 105*l.*; repairs having been "nothing serious." The performance is from 4 to 8 acres ploughed, or 6 to 14 acres cultivated per day. All the hands are common labourers. Coals cost 20*s.* per ton. To shift the apparatus takes 4 horses, for half a day. The tackle is confined to the farm, but the engine is used to do the thrashing. Mr. Parsons considers that the drainage is more effectual, and that his crops generally are more productive. The farm having been added to from time to time, the proportionate reduction of horse-flesh is not stated.

The following is a Table similar to that furnished at the close of each of our divisions :—

Reference No. of the Farm.	Acres Arable.	Nature of Soil.	Apparatus.	Horse-power of Engine.	Acres Ploughed per Day.	Total Cost per Acre.	Acres Cultivated per Day.	Total Cost per Acre.	Total Yearly Cost of Steam Tillage.	Reduction in Number of Horses.	Number of Horses now kept to each 100 Acres.
77	274	Strong clay	Fowler & Williams	12	5 to 6	..	10 to 12	..	..	11 to 6	$2\frac{1}{4}$
78	380	Clay and loam ..	Fowler	14	6 to 7	..	9 to 10	..	..	16 bullocks saved	$2\frac{1}{2}$
79	400	Heavy	Fowler	10	5 to 6	..	8 to 10	..	..	3 horses and 10 bullocks saved	$2\frac{1}{4}$
80	540	Clay and stonebrash	Fowler	10	5	..	10	..	..	..	$2\frac{1}{4}$
81	500	Very heavy	Fowler & Pocock	10	5	..	8 to 16	..	£160	12 to 14 horses saved	..
82	620	Clay and loam ..	Fowler	Two 14	10	..	..	..	..	28 oxen saved	$1\frac{3}{4}$
83	600	Strong loam	Fowler	12	8 to 10	..	..	..	..	12 oxen saved	$2\frac{1}{2}$
84	1000	Very heavy	Fowler	12	5 to 10	..	10 to 20	..	..	20 oxen and 3 horses saved	..
85	700	Clay and chalk, very hilly	Howard	10	..	..	5 to 9	..	..	32 to 22	3
86	1700	Clay, &c.	Fowler	12	4 to 8	..	6 to 14	..	..	..	..

Division 4.—North.

No. 87. Mr. William Bethell, of Rise Park, Hull, East Riding of Yorkshire. Leaving Hull in a north-easterly direction, the Hornsea road traverses a "marsh" flat of pasture and rich brown alluvial plough-land, and then, passing the town of Hedon on the right, enters upon the diluvial district of Holderness, a slightly-undulating, strong loam, wheat and bean country; both arable and grass land lying in ridges, but these neither very wide nor high-backed. At the twelfth mile along this road we come to the stately mansion of Mr. Bethell, who has three farms, the home farm here, which is under steam cultivation, comprising 280 acres arable, with 170 of grass. The soil is a strong loam, with a subsoil of strong drift-clay containing small pebbles, in some places with sand, in others gravel. Pair-horse ploughing is practised; a day's work being about 3 roods, or sometimes an acre. The ploughmen, or "chaff-cutters," are, for the most part, young fellows lodged and boarded upon beef and bacon, and paid 8*l.* 10*s.*, or 11*l.* each yearly wages; and, feeding and working their teams from half-past 4 or 5 o'clock in the morning till 7 at night, in summer, these are cheaper men than the ordinary weekly labourers at 2*s.* 6*d.* a day.

The farm has been prepared for steam tillage. It has a 4-feet deep pipe drainage at 9-yard intervals, and drains well though always ploughed in "broad work," that is, flat. The ditches have been filled in, and the pipe mains led into small tanks at the corners of the fields, each tank say 6 feet wide and 9 feet deep; these being bricked, but not laid in cement, as the clay itself holds the water, and the surplus passes away through an overflow-pipe. When a field comes in for seeds, a pump is put up at the corner tank; and this water always supplies the engine, either with the use of a cart or (if near) of a water-barrow. There are few hedgerow trees, and the quicks are kept low. Our observation on walking over the land was, that the stubbles were stout and good, and the Skirving swedes a magnificent crop; and we instinctively complimented Northgraves, the bailiff, on being able to show one of the cleanest farms we had met with in the whole round of our travels; in fact, the fields are so free from couch that even forking is not needed.

Mr. Bethell has a 14-horse Fowler set, with plough and cultivator, and most of his steam work has been done with the latter implement. This breaks up wheat or bean stubble after harvest 9 or 10 inches deep; the tilth then lies for a time, and in dry weather is cross-scarified by horses for the fallow crop. No cross-cultivating has been done by the steam-engine. A portion of the farm used to be bare-fallowed; but now all is

cropped, and 30 or 40 acres more of roots must therefore be placed to the credit of the steam-plough. The bailiff, who has been here eight years, and therefore ought to know, affirms that the three years of steam tillage have given a decided increase in the yield of corn, and this on a farm that was "well done" before the steam power came. And he bore witness to the fact of the land drying more quickly in consequence of the deeper cultivation.

We did not ascertain the expenses of working the steam-plough; but though wages here are high, coal is comparatively cheap, namely 13*s.* per ton. The former force of 14 horses has been reduced to 10, yet harvesting and carting-out manure are accomplished without delay, and these horses do estate work as well.

Our details of this example may not be very full and complete, but the apparatus is evidently successful, and gives the proprietor satisfaction.*

No. 88. Mr. Samuel Strickland, of Headley Hall, Tadcaster, West Riding of Yorkshire, occupies 300 acres arable, and 30 of grass, in a gently undulating limestone district, divided into moderate-sized inclosures; the fields here varying from 14 to 40 acres each. The soil is a strong calcareous loam, "3 or 4-horse ploughing," but does not all need underdrainage; much of the farm has been drained, but Mr. Strickland says "the steam-plough is the best drainer."

In 1862 he purchased a second-hand 12-horse Fowler tackle, with 7-tined cultivator and 3-furrow plough, which had been in use only three months, and the cost price, by auction at Leamington, was 548*l.*; repairs and getting home cost 64*l.* 16*s.*, making the investment 612*l.* 16*s.* This year he has just had a heavy expenditure upon it, including a new fire-box, from using dirty water, and the repairs for four years amount to 118*l.* 16*s.* Of this, 20*l.* a year has been the cost of rope. Many cast-metal skifes have been broken by the stones; but since steel skifes have been substituted, no fractures of this sort have occurred. They have never broken a rope, but "the first is quite worn out 1867), and a new one bought." Before the steam-plough came hey used to work a 3-tined Bentall 2 or 3 inches deep, with 4 horses, [illegible]tting over about 5 acres in a hard day's work. Now, the [illegible] cultivator will do as much as 20 acres in a long day, and a depth of 10 to 12, or even 15 inches; and the plough (Mr. Strickland does not like the "digging") will do 4 acres a day, [illegible]king furrows 14 inches wide and 12 inches deep, occasionally [illegible] inches deep. The previous horse-ploughing used to be 4 to

* [illegible] in obtaining efficient engine-men.—W. B.

6 inches deep. With a soil that will permit of such profound culture as this, no wonder that Mr. Strickland wishes that his engine had been a "14" instead of a "12-horse power." We noticed that this engine, like some others we have seen, is roofed over, as a protection from rain and sun.

Coals are cheap here, "slack" being used, at 3*s* 4*d*. a ton, with 2*s*. 6*d*. more for leading home; and the engine burns 1 cwt. an acre when cultivating, or 2 cwts. an acre when deep ploughing. Oil costs 1*s*. 3*d*. a day; water has to be fetched a distance of 2 miles; a couple of water-carts, however, more than supplying the engine. Indeed, all the watering of the live stock on this farm has to be done by this carriage, a deep well being required. The manual labour consists of two men at 2*s*. 4*d*. each, and four at 2*s*. each—these hands being employed at other times on the farm. A shift generally takes 2 to 2½ hours, but the anchorage (when mounted on its travelling-wheels) has been hauled up to the engine (by the rope) directly a field was finished, and both engine and anchorage placed in another field ready for work, with the exception of leading out the rope, in three-quarters of an hour. Two horses are always requisite for pulling out the rope.

The farm is managed on a 7-course system. The wheat stubble is "cultivated-up" by steam, for the fallow-crop—which consists of swedes, without white turnips or mangolds; the rough work is allowed to lie all winter, and is then crossed in spring. This answers for cleaning the land, and there is certainly not much "wicks" now visible. The seeds are ploughed by horses, not very deeply, for wheat; after this comes the potato-crop, and when the tubers have been taken up the land is steam-cultivated for wheat. All the fields are worked or ploughed perfectly flat, and all the seed-beds are prepared by the steam-engine, except that after seeds for wheat; the area of work done in four years having been 813 acres cultivated 8 to 15 inches deep, and 278 acres ploughed from 12 to 15 inches deep—these measurements, of course, being stated on Mr. Strickland's authority. The engine also thrashes all those well-built well-arranged ricks which are here placed (for safety) diamond-wise, at 30 yards apart.

The headlands are not worked by steam, because it would not answer to delay the tackle for the purpose. When doing the deep tillage, first time over, they were obliged to place a couple of 4-stone weights upon the implement besides the ploughman, to hold it down among the stones; but the land now works with 20 lbs. less pressure of steam than was needed the first year.

By steam cultivation Mr. Strickland has been enabled to grow a larger breadth of root-crop, and to take green crops every alter-

nate year. The land drains better; he never before got such fine tilths for turnips, and they can be fed-off with greater advantage. He says also that his grain-crops have been greatly more productive—"I think I can afford wheat and barley at 5*s.* per quarter less by steam than on the old system." Both Mr. Strickland and his son are extremely practical people, but as enthusiastic about steam-husbandry as they are over their young cart and other stallions; in fact, the father said, "I am an old man, but I would give Lord Headley notice to quit if I might not or could not have a steam-plough." Readers may, in perusing our account of this farm, make allowance for this warmth of feeling; but the following is Mr. Strickland's statement of his gain in the displacement of horse-flesh. He used to keep 14 farm-horses, now he has only 8; these teams, with the help of two or three young ones in harvest, cart all the corn, do all the light tillage, lead-out manure for the potato-crop—the turnips (and sometimes the seeds) being only "artificialled"—and last year these 8 horses likewise carried the produce of 64 acres of potatoes to Leeds, 11 miles off, bringing back night-soil, or slack or coal from the pits. Before the steam-engine was introduced, although he had 14 horses, he was obliged to hire teams, or rather to have all this potato carriage done by contract, paying the men 10*s.* a ton; so that in the mere delivery of one year's potato-crop to market he saves no less a sum than 200*l.* In addition to this, of course, there is the yearly saving from the banishment of 6 horses by the steam-engine, amounting to 264*l.*,—making a total of 464*l.* a year, out of which has to be defrayed the cost of the average annual performance of about 273 acres of very deep tillage.

No. 89. Mr. Henry Hawking, of Ellinthorpe, near Boro-bridge, North Riding of Yorkshire, occupies 225 acres of arable, and 115 acres of old pasture, under "Her Majesty," and has also about 190 acres arable on another farm, 7 or 8 miles away, at Tholthorpe, near Easingwold. A 14-horse Fowler "set" does some cultivating on the off-farm, after harvest, but is mainly employed at Ellinthorpe, doing all the heavy tillage here, so that the 225 acres may be considered as the farm under steam cultivation. About two-thirds of it consist of loam upon "a good strong" subsoil, having sand at a very considerable depth below—this heavy subsoil containing small nodules of stone; in fact it is a drift deposit, and its surface undulates very slightly at a level, perhaps 10 or 20 feet higher than that of the horizontal warp clay of the Ure, which is a heavier soil, occupying the other third of the farm. Under-drainage at 5 feet depth, and 8 or 9-yard intervals, has only just been finished, a portion having been done each year; the land is ploughed quite flat, and drains

better since it has been steam-ploughed: still, Mr. Hawking considers that steam tillage cannot be conveniently done upon land the first year after draining, as the wheels of the plough sink into the drains. The farm was entered upon in April, 1863, and in the three years 170 acres have been drained by Mr. Hawking solely at his own expense, the Crown neither paying for pipes nor labour; this tedious but fundamental operation necessitating more horse-work, and less steam-work, than will be required in future years. Nevertheless, 8 horses and the engine together have done all the tillage and draft labour of the farm, excepting that, in extra busy times, team help has been borrowed from Tholthorpe, and paid back again. The force formerly kept was 12 horses.

Mr. Hawking has thrown the fields together till they now average about 30 acres apiece, instead of 10 acres; there used to be 47 fields, but now he has only 7 arable and 8 grass. This has been done purposely to facilitate steam culture, and the drains empty into small tanks in the field corners to supply the water-cart or hand-barrow.

The 14-horse engine, anchorage, tackle, 4-furrow plough, and 7-tined cultivator, were bought second-hand in 1863; and in the four years have cost 230*l.*, or 47*l.* per annum for repairs, occasioned by wear and by breakages. This experience tells against buying steam-machinery second-hand of a man whose business was steam-ploughing by contract; but much of the damage arose from the employment of inexperienced hands in working the apparatus. From the same cause, too, the extent of work done in 1864 and in 1865 was much less than in 1866, when a better staff of fellows had been found; in fact, these latter got over nearly double the quantity of ground per day.

In 1865, 155 acres were cultivated in 24½ days, or about 6⅓ acres per day. Then 37 acres were ploughed in 10 days, or an average of 3¾ acres per day, two days of the time being lost by breakage of ropes. Of digging, 21 acres were done in 5 days, during which the rope was broken no less than eight times. Mr. Hawking's estimate of the daily expense is as follows:—

	£.	s.	d.
Wages of 4 men and 2 boys	0	14	10
Horse, carting about 1200 gallons of water from ponds and wells, or from the field tanks	0	2	6
Oil	0	1	0
Coal, at 13*s.* per ton, over ½ a ton	0	8	0
Repairs, &c.	1	10	0
	2	16	4

This account omits removals, which require 3 horses for 3 or

4 hours (though it has been done in 2 hours), but it makes no allowance, on the other hand, for the use of the engine in thrashing the farm corn. And 60*l.* a-year for "repairs, &c.," (*i.e.* 40 days work at 1*l.* 10*s.*) does not leave a margin for interest and depreciation, even on a low first-cost, when the 47*l.* for actual repairs and rope has been deducted. We do not think it worth while to estimate closely the total cost of work done with a second-hand tackle, because the value and condition of the apparatus at starting being unknown, the calculation would be no guide to what might be experienced with new machinery; but at the above figures the total cost of the cultivating was 8*s.* 10*d.*; of the ploughing, 15*s.* per acre; and of the digging, 13*s.* 2*d.* per acre. It must be remembered, however, that this ploughing was done 12 inches deep, and the digging 12 to 15 inches deep.

In 1866, better men made greater economy in the work. For 10 days they cultivated 91 acres, or fully 9 acres a day, at no less a depth than 16 inches, the deepest work we have met with on any farm, excepting Mr. Wright's of Beal (see No. 94), at a cost of 6*s.* 3*d.* per acre. And in 4½ days they ploughed, 6 inches deep, 26 acres, or about 6 acres a day, at 9*s.* 4*d.* per acre. Since then it has been found that an average day's work is about 5¼ or 6 acres of ploughing or digging, or 10 to 12 acres of cultivating.

The great depth of Mr. Hawking's work demands a few words. We found the engine at work in a piece foul with "wicks" (for the outgoing tenant was good enough to leave a few playthings for the incomer to amuse himself with, not to mention one field on which a crop of seedling (!) docks came up so thickly that a man could scarcely set his foot down without treading on one of these friendly plants); it was making splendid work with the digger, a good 12 inches deep by the landside of the furrow, and at the rate of 7 acres a day. Mr. Hawking is not a bit nervous about burying the couch, which is of the rare old stringy sort, easily pulled out; and other fields now extremely clean had been just as full of root-weed. The soil is very deep, and as fertile as deep, and therefore very deep culture answers well; farmers here thinking that farmers in other parts of England who are content with 5 and 6-inch ploughing, must certainly be asleep. Mr. Hawking had a piece of seeds in 1863, all grazed and treated alike: part was steam-ploughed, 10 inches deep (the slices cut as wide as they were deep, so that, when turned one-fourth over, they lay square, flat side to flat side, and level on the top, missing the hollow spaces left under the slices in the customary "angle" ploughing); the other part of the field was horse-ploughed 5 inches, that is, just half the depth. All was sown with wheat; and in harvest not only showed the steam-

ploughed wheat to be the best crop, but, on thrashing out, it yielded 12 bushels more corn per acre than that on the shallow-ploughed part. Mr. Hawking says, moreover, that the horse-ploughed part is better land than the other. Stranger still, the deep steam-work was done immediately before drilling, and the shallow work was done a month earlier.

The course of cropping is alternate; but Her Majesty's tenants are bound by restrictive articles, so that they cannot produce as they would; and Mr. Hawking is not therefore at liberty to vary his rotation, even though the steam-plough enabled him to do so. The steam-engine smashes up stubble for the root-crop, and tills part of the turnip-fold for barley. Part of this is followed by seeds; part of the barley-stubble is steam-tilled for beans; and the steam-engine makes the bean-stubble into a seed-bed for wheat. Of course, no man can say in the first four years occupation of his farm how far his crops are improved by steam tillage, but the crops have been considered very good, and Mr. Hawking's opinion is that the roots have been more benefited than the corn.

We may add one or two notes that we made on the spot. Labourers here have 12*s*. a week and house-rent, amounting altogether to about 15*s*. a week, while young men are boarded and lodged, and paid a yearly wage.

Mr. Hawking has contrived a reel, placed in a cart and made to revolve by spur-wheels from the cart-wheels, by which arrangement the rope is laid out or coiled up again for travelling, without wearing it by dragging along the ground. However, in its present form, this is too heavy a thing to be commonly used.

Mr. Hawking, a very practical man and good manager, pronounces steam cultivation to be superior to all other systems upon well-drained land; but he thinks the conclusion of experience is, that, on a farm having less than 500 acres of arable, it is not advisable to purchase an apparatus. He would like to "get rid of the anchor," which causes such a loss of time in shifting from one field to another. And to do this without an excessive outlay on a farm of this dimension (225 acres arable), it would be necessary for him to start either a Steam-Ploughing Company or to join in partnership with another farmer having an engine, so that the two engines could till together; and when, not in the field, one engine could thrash and grind at the homestead, while the other might travel with a thrashing-machine to contract jobs round the neighbourhood.

No. 90. The Hon. Payan Dawnay, of Beningbrough Hall, York, has at present in his own hands about 1000 acres, in four farms lying apart, being "land run out by tenants." The arable is about "two-thirds more than pasture," chiefly strong soil, some

very heavy. Before steam-husbandry was commenced, the fields were mostly enlarged by stubbing hedges, and on one farm they are of 15 and 19 acres each. "This country," writes the proprietor, "is as flat as my hand, and is now mostly drained; but flat land does not dry so quickly as a rolling country. . . . Last August (1865) the engine grubbed (for I care not for ploughing) 20 acres of land that no plough with 3 horses ever could touch; it is now (summer of 1866) in barley, and looks promising; the field never was wet all the last winter . . . . Two fields for the most part strong land, though not entirely so (the soil varying considerably), were beautifully dry all the last wet winter. One of these fields is now in wheat, I think as good and as forward as any in the neighbourhood." This effective drying is attributed to the deep tillage of the cultivator. But he adds, "I fear that on such land we can never hope to feed off root-crops; the ground is so flat that it would get puddled at the top with sheep in damp weather." Most of the fields have ponds, through which the main drain of the land runs; and a horse and water-cart supply the engine with about 3½ tons of water per day from this source. With a 10-horse Fowler engine, and "one of the early made" grubbers, about 7½ acres per day are broken up, coals being burnt at the rate of 15 cwts. in 10 hours, costing, at 10*s.* per ton, 7*s.* 6*d.*; oil, and cotton-waste for cleaning, cost 1*s.* 3*d.* daily. The cost of labour was in 1866—foreman, 14*s.*; engine-driver, 15*s.*; other farm labourers, 12*s.* each per week; the engine-driver, when not steam-cultivating, works a fixed engine for grinding, &c.; and the other hands are farm-labourers. Three horses and six men shift the tackle. "The average time for fixing engine and tackle in the field ready for work is one hour after arrival in the field, 45 minutes to get up steam, and one hour to dismantle for removal."

The apparatus was purchased two years ago, second-hand, and has cost about 700*l.*, inclusive of repairs and additions. Thorough repair, lately executed, cost 300*l.*; ropes had previously cost about 70*l.* In fact, the engine and tackle had done a great deal of work in the neighbourhood of Selby, and therefore wanted a great deal of renewing; moreover, the former owner had laid it aside for some months, "and rust, &c., is prejudicial." Now it does nothing else but tillage work; two of the farms having fixed engines which thrash, and one also drives a mill, pumps, cuts chaff, pulps turnips, and so on. The engine is not let for hire, but, at the date when the schedule of queries was filled up, was "grubbing (or smashing, I don't know which you call it), for a new tenant, a field that is an entire mass of couch and thistles, the former tenant having left the land in a disgraceful condition."

The course of cropping has not been altered; the plan pursued being to keep seeds down for three years, and then alternate white corn and forage crops,—meaning beans and turnips.

In reply to the question about number of horses, the schedule simply says: "A squire must always have more horses than a tenant-farmer, as he has so much estate work, as bricks, coals, &c., to be carted." And respecting productiveness of crops, it says: "I can scarcely write anything here, except that one field was began to be ploughed by steam in '64 in the autumn; when the men had done about 2 acres, the machinery, &c., came to shocking grief, and the rest of the field was ploughed by horse-ploughs, and sown with oats in the spring. But through all the growing time of 1865, the oats showed almost to an inch where the steam-plough had worked. We never made any difference in the stacking, so I cannot report the increase of corn and straw, but it doubtless was considerable."

This gentleman's experience is one more caution against investing in second-hand engines that have seen much service. But as we have already related, there are cases (for instance, when a new tackle has had only a few months' wear) in which "the trade might do."

No. 91. Mr. J. Wilson, of Woodhorn Manor, Morpeth, Northumberland. Eight miles east of Morpeth, and within half-a-mile of the rocks which beat back the waves of the German Ocean, is situated the village of Woodhorn, with its Manor House, the residence of Mr. Wilson. The farm, of 450 acres arable, and 250 acres grass, for the most part level, with low fences and not much wood, has a strong loam soil, with some portions of lighter loam, resting upon the clay of the coal measures, which clay in some of the fields forms the staple soil. The very big, powerful horses here employed make pair-horse ploughing at 6 to 8 inches' depth; fallow-ploughing, at 9 inches' depth, requiring a team of three.

The inclosures on half the farm average 20 acres each; on the rest, 10 to 15 acres each; their angular and irregular shape being due in a great measure to the passing of three public roads through the farm. A projected railway, also, is laid out to cross this occupation, and when the work has been completed, the necessary squaring and straightening, as well as grubbing-up of fences, will be at once executed. The drainage has been done 4 feet deep, at 21 to 24 feet distances apart, and the old ridges were partly ploughed flat and levelled before the steam-engine came. The drains act well, and, with the exception of a vein of stiff clay land, the soil dries quickly after wet—a decided improvement having been observed since the use of the steam-plough. We should add that the annual rain-fall here exceeds 30 inches.

In April, 1865, Mr. Wilson purchased a pair of Fowler 10-horse engines—each a single-cylinder, self-travelling engine, with rope-winding drum under the boiler—working a 4-furrow plough or digger, a balance-cultivator 5 feet wide, or a harrow taking 16 feet breadth at once. The prime cost of this "double set" was 1300*l.* This being only the second set of this pattern that had then been manufactured, it was not sent out quite perfect in every detail; and, owing to the skifes being of cast-metal, many were fractured by the big stones. But now that steel skifes have been substituted, breakage does not occur—the stones being lifted up; and difficulty with stones is not met with after the first deep tillage, during which they are worked and dug out by hand. The cost of these new pieces, and the petty repairs together, have amounted to about 25*l.*, besides "additional" parts costing 30*l.* The ropes have been broken once or twice; but they are in good order, and it is too early yet to say what either the consumption of rope or repairs of wearing parts will be. The daily working expenses are as follow:—coal is burned at the rate of 16 cwts. for the two engines, costing 3*s.* 6*d.* or 4*s.* a ton, at the pit, three miles off; or 5*s.* to 5*s.* 6*d.*, delivered in the country style by one man driving two single-horse carts: say the fuel costs 3*s.* 6*d.* per day. Oil, "3 gills," costs 1*s.* One horse fetches water from wells and ponds, or from several ditches which cross the farm—say at a cost of 4*s.* Labour is an expensive item; and the fashion here is to keep for each labourer a cow on grass in summer, and on two loads of hay with straw *ad libitum* in winter,—this keep of a cow being considered worth 5*s.* a week of wages. Ordinary labourers, in fact, earn 15*s.* a week and a house to live in. The steam-hands are ordinary farm-labourers, excepting one engine-man, who came from Messrs. Fowler; he is paid 3*s.* 6*d.* a day; the other engine-man, 3*s.* a day; the ploughman, 2*s.* 6*d.*; the water-cart lad 2*s.*, and a couple of porter-boys, 1*s.* each; and in addition the men have their houses rent-free. As the engines can "do everything for themselves," even to leading-out their own rope, they require for "removal" "no horses and no extra men;" and they accomplish the operation in about 20 minutes, when the shift is from one field into another adjoining. But on the advantages of this despatch we shall have something to say presently. We should say here that all the steam-hands are "volunteers,"—as, at first starting, the man set to the plough got unluckily pitched off the implement, turned over on his back, and hurt; but now, so much interest is taken in the apparatus that even the boys have learned how to drive the engines, and though the Leeds man (we have no doubt) is a valuable fellow to have with the tackle, Mr. Wilson feels himself quite independent in the matter of labour, and could always man his machinery

efficiently. We found the gang all in "white duck" suits, caps and jackets, in regular engineer's fashion—which simple circumstance appeared to tell much about elevation of farm-labourers from the old plough-tail drudgery, and the heavy *physique* and slow mental apprehension inevitably connected with long slops, coarse corduroys, and lumbering high-lows.

The performance of the tackle amounts to 6 up to 9 acres ploughed or dug, or 10 to 16 acres cultivated in a day of 10 hours. From September 14th, 1865, to November 17th, 1866, the work done was—

			Acres.
Of digging, in	.. 51	days of 10 hours each	394
„ cultivating, in	20	„	253
„ harrowing, in	12	„	448
	83	„	1095

Thus an average day's work was—of digging, $7\frac{2}{3}$ acres; of cultivating, $12\frac{2}{3}$ acres; and of harrowing, $37\frac{1}{3}$ acres. For these 83 "days' work" steam was "got-up" on 127 days; and much more work would have been done had it not been for the stones met with in this first year's breaking into the subsoil.

Mr. Wilson's "home" buildings (where, by-the-by, we saw one of the best contrived and best appointed piggeries yet devised) having a fixed engine for thrashing, grinding, &c., he does not at present put the ploughing-engines to any but their tillage engagements; but at an "off" farmstead he is going to have a fixed machine, which will be driven by one of the plough-engines. We may observe, in this place, that one reason why steam culture extends slowly in these northern latitudes, where the price of fuel is so tempting, is because almost every barn has its steam-engine chimney of brick instead of iron—that is, fixed instead of portable engines everywhere abound; and though in many quarters there has been no objection to oust the old Scotch thrashing-boxes, and put in grain-saving modern English ones, it is a very different matter to abolish the fixture-engine system altogether.

Mr. Wilson's double-engine apparatus has done some work for neighbours; that is, over 235 acres upon nine farms, since autumn, 1865. The charges are—for ploughing or digging, 10*s.* to 14*s.* per acre on light land, and 12*s.* to 21*s.* on strong land; and for cultivating once over, 10*s.* to 12*s.* per acre on light, and 10*s.* to 15*s.* on strong land; and for cultivating twice over, 16*s.* to 20*s.* per acre on light, and 20*s.* to 26*s.* on strong land. The farmers find coal and water. On this contract-work the steam-hands have a "perquisite"—3*d.* per acre to the "head engineer," and a "*douceur*" to each of the other men and boys. One result is, that a next-door neighbour has parted with

3 horses, in consequence of being able to hire this machinery. Mr. Wilson himself has disposed of three "pairs;" now keeping 12 horses, whereas 18 are the force due to his quantity of arable, according to the system of culture and usage of the locality.

There has been no time yet for any proved augmentation of cropping, except that the acreage of roots has been at once enlarged, and that the yield of beans as well as roots is thought to be improved. The rotation has been mainly 4-course, partly a 5-course shift—(1) turnips; (2) wheat and barley; (3) clover and beans; and (4) oats; a portion was always dead-fallowed before the engine appeared, but now all under crop; and Mr. Wilson says, "I find I can grow turnips on land upon which they were never grown before." We were told that the swedes we walked over were the only ones in the neighbourhood that had been but once sown, the flies having taken off the plant in all pieces that had not the depth of moist staple here provided by steam tillage.

After harvest the wheat-stubble is steam-dug for beans, and the oat-stubble dug for the fallow crop—the work being 11 to 13 inches deep, this being regulated by the subsoil, some of the land being too close to the rock for the deepest work. After this, the engines go for a time to other people's farms. The majority of the turnips are carted off, some eaten on the land, and the seed-beds for wheat or barley are made by the balance-cultivator or plough. The clover-lea of 1865 was horse-ploughed, but all steam-ploughed in 1866, except a small breadth which was dug.

At the time of our visit (November 19th) a severe frost had set in, and Mr. Wilson's polite determination to show us the machinery in actual operation led to the snapping of a rope, from the excessive hardness of the ground, after only an acre or two had been ploughed. At any rate this accident gave us the opportunity of watching a smart "splice," including 8 feet of rope unstranded and made right and tight again in a short half-hour. The rope is in very good trim, and we noticed that, contrary to the common practice with the single line of rope, or "double-engine" system, porters were used here at every 40 yards' distance. We noticed that while one of the engines coils its rope beautifully, the other occasionally suffers the rope to "cross"—the perfect adjustment of the very clever coiling mechanism being a difficult matter. The defectively-wound rope is visibly more worn than the other, and the engineer said that while this has been broken [illegible] the other has been broken but once. This is a commentary on the coiling of rope upon itself.

Mr. Wilson says that the harrow makes a magnificent seed-bed for corn or turnips; and, as an example of its use, favoured

us with the following fact:—"North Scatter-broom," a field of only 9 acres (and therefore in "short lengths") had been steam-dug in the autumn of 1865, and laid all winter. On the 8th of May, 1866, it was steam-cultivated in five hours, between seven o'clock and noon; the cultivator was then taken off and the harrow put to work crosswise (or, as the Norfolk men say, "overwart"); the harrow traversed the whole piece, and then back again the same way, before nightfall. Thus the field had been cultivated and twice harrowed, making in all (9 + 18) 27 acres of steam tillage in one day. A horse-roller had followed before the second harrowing; and there is no reason that we know of why a roller should not be attached to the harrow-frame—in fact, we did see an arrangement of this very kind, contrived by Mr. J. A. Williams at Baydon. Next day after this steam-cultivating and steam-harrowing, a light horse-roller and a horse-harrow were used, and the field drilled with swedes. In turnip-sowing time the steam-cultivator was kept going "about two days a-head," so as to keep in the moisture; and the tilth was "like a garden," yet without the least danger of getting run together by a heavy fall of wet, because the pulverulent seed-bed was not a mass of dry clodlets and dust, but of already moist mould indisposed to cohere.

The *expedition* illustrated in this case forms one of the chief arguments in favour of the 2-engine system. Such are the ease and celerity with which the engines take and fetch their implements, pull out their ropes, and so on, that only 10 minutes were intermitted from actual work on that day in exchanging the cultivator for the harrow—this being done by one engine, while the other was simultaneously taking up its position and laying its rope for harrowing across the field. If a single engine and anchorage had been used, the shifting would have occupied so long that only a small part of the cross-harrowing could have been done, the turnip-sowing would have been delayed a day, and, had it been in a catching season, the critical time lost might have been indefinitely postponed by drenching rains.

Shifting the apparatus from one field to another is done in this way: the plough goes its last journey without trailing out the return rope behind it, consequently the engine at that end from which the plough is starting in its last furrow is at liberty to travel, which it immediately does, taking its rope coiled upon its drum, just as it left off hauling the implement; and this engine, on arriving at the entrance of the next field where work is to be done, waits there till the second engine comes, bringing the plough with it. The rope of engine No. 1 is then hooked to the plough, and engine No. 2 marches across the field to its required position on the far headland, taking the plough with it, and simultaneously laying out the rope.

This *independence* is a grand point in the 2-engine system: the three men and the boys take their engines and whole apparatus where they like, without interrupting the other business of the farm for horses and men to shift them; whereas the single-engine set, having its anchorage to mount on carriage-wheels and set down again, wants two or three horses and an extra man with them, for two or three hours, after about every three days' work. A roundabout "windlass" set, of course, is "in the same boat." And though the actual expense thus added upon each working day is not very considerable, the loss of time of the engine and the loss of time of the horses from perhaps most urgent tillage-work, frequently backward operations much more than for the quarter or half day which may be actually consumed in the removal. Every one will understand the disadvantage of breaking off two or three horses, which are indispensable to complete a field "set," as in wheat-seeding or manuring, for the hindrance so arising may involve days of delay in finishing a job if wet should happen to fall.

In actual work the 2-engine system wastes far less time than the single-engine system does. In fields of irregular figure, many a half-hour may be lost by the anchorage-system in shortening or adding to the rope, only a small surplus length being carried upon the plough; but with two engines, no lengths have to be added or removed. When the implement is drawing near to the anchor the pace has to be slackened, for the sake of a cautious approach and giving opportunity for the signalling. With two engines there are no signals when all is right; the plough is pulled up to the engine at either end, and it is surprising with what dexterity and neatness the stopping is done by men who have had practice. Thus Clayton, Mr. Wilson's engine-driver, who came from Messrs. Fowler, can drive for a whole day, drawing up the plough every time within 4 inches of the fly-wheel—a fineness of running done by smart movement of the reversing-gear lever. On the double-engine plan no time whatever is lost in firing, oiling, &c. When the plough is going out, the engine-driver has leisure for putting on the right quantity of coal and in a proper manner, he can rake and brighten his fire, he can oil, attend to the pump, ret-cock, &c., and look round to see that things are right; and then when it is his engine's turn to pull, he has nothing to do but to watch the plough, in instant readiness for stoppage at a rock or a root, or the first show of a signal. On the contrary, the driver of a single engine has no time for properly firing, &c., if he keeps the requisite sharp look-out upon the implement, and he has to stop work occasionally in order to get things into trim.

The "double" engines lose not a second in moving forward on

the headland, because the resting engine takes up a new position while the other is pulling. The single engine has to move forward at every bout when the implement has come to that end. This cannot be done while the plough is in motion; and as moving forward before the plough starts puts the slack-rope in the ploughman's way, the usual plan is to set the plough in for a yard or two, stop it, put the road-gear in action, travel the engine forward, and then again start the plough on its journey out. Considering the loss of time, as well as occasional stoppages, and the slackening of speed in approaching the anchorage, we may fairly say that in farmer's practice the single engine takes half a minute, while the double engines take only a quarter of a minute in "turning at the ends." If we allow three minutes for each journey of the implement, the single engine is seen to waste one-seventh of the day, and the two engines only one-fourteenth of the day, "at the ends;" that is, the double engines compress nearly one day's more work into a week. About every third day the single engine wastes say three hours in removal for half a mile distance; the double engines waste only half an hour in effecting the same shift; thus gaining 2½ hours twice a week, or another half a day in the week. The result is that, assuming the plough to move in both cases at the same pace, two engines will accomplish in 6 days the same amount of work that one engine will do in 7½ days; or, in other words, they will get over 75 acres, while the single engine is doing only 60 acres.

Perhaps we shall not be far from the truth if we take this as a fair comparison between a 14-horse engine and anchorage "set," and a "double set" of two 12-horse engines; with either of the "sets" the implement would probably be hauled at about the same pace, yet the "double" would accomplish in the same time one-fourth more work than the "single" tackle. With the "two" engines the prime cost, and therefore the interest and depreciation per day, would be one-fourth more—thus amounting to only the same charge per acre as with the single engine. But there would be a saving in working expenses; because the coal burned and the wages paid per day are about equal in the two cases, making the "double engine" performance one-fifth cheaper in coal and labour per acre.

We are not surprised, then, to find that no purchaser of a "double" set has yet been known to go back to the "single" set of steam-ploughing tackle, though there are many instances of "single" sets being relinquished for "double" ones—an exchange by no means confined to men who contemplate letting out their machinery. (See farms Nos. 69 and 82.) Of course, the sum of money required will prevent the occupier of a small farm from

investing in such a costly "plant," unless he be prepared to undertake a great deal of work for other people.

Mr. Wilson has accomplished the novel performance of ridge-and-furrow ploughing by steam-power. Horses "open furrows" at intervals where the "ridges" are to be: the 4-furrow plough is then taken twice along each side; that is, it throws 8 furrows toward the "ridge" on one side, and then being turned "end for end," the implement throws 8 furrows toward the "ridge" on the other side,—thus forming a "land" or "stetch" of 16 furrows breadth. A horse-plough "makes up" the "balk and mole-furrow." This practice has been followed upon the turnip-fields this winter.

Before passing on to another farm, we may here advert to another mode of working, likely (we should think) to supersede the "double-engine system," if not in the hands of farmers, at any rate in the hands of contract-men and companies, who are better able to manage elaborate arrangements of machinery. We have now in the field a method followed by Messrs. Howard, which may be called the "double-double" or the "half-way" system. This consists of two engines, and also two implements; engine No. 1 pulling implement A one way, while engine No. 2 is pulling implement B the other way; and then engine No. 1 pulling B back again while implement A is pulled back again by engine No. 2. But in order to avoid unhooking ropes and crossing work, the journeys are of only half length, both implements travelling from their respective engines to the middle of the field, where they meet,—but not quite in the same line, so that they can pass each other at a distance of about their own length, just enough to make the furrow-ends meet, instead of leaving a strip of uncut ground.

The plan is promising, as will appear from a contrast very easily made in figures. Suppose that, on the old double-engine system, one implement, 7 feet wide, traverses from engine to engine in 200 seconds, and takes 10 seconds to turn; that is, a stripe of land 7 feet broad and the whole length of the field, is cultivated in 210 seconds. Now take the same two engines in the same position, but with two implements meeting mid-way. There being two plys of rope instead of only one, we must reduce the width of each implement to say 6 feet, in order that the engine may be able to pull it at the same pace as in the former case; say then that two 6-feet wide implements travel at the same pace,—they will accomplish their half-way journey in 100 seconds. Then, as the engines have to shift forward on the headland while the implements are at the ends, a longer time will be wasted, say 20 seconds in "turning" at the end: that is,

the half-journey is accomplished in 120 seconds. But then, as there are two 6-feet implements simultaneously travelling, a stripe of land, 6 feet broad, has been cultivated the whole length of the field between the two engines. The comparison is this: —the double-engine system has tilled a foot breadth (of the whole length of the field) in every 30 seconds; whereas the double implement and double-engine system has tilled a foot breadth (of the same length) in every 20 seconds. In other words, the new plan is capable of working as large an area in 2 hours as the old plan can do in 3 hours; or, in other words again, you may henceforth get your 6 weeks' work of autumn-tillage finished in 4 weeks,—and for much less money; because, while there is an additional ploughman, with a slight increase in the coal, oil, and water-bill, you have only two-thirds the number of days on which any expense at all has to be incurred.

We believe that Messrs. Fowler also find no difficulty in working two implements at once by two engines with clip-drums, and "slack-gear" upon each implement. If so, this at once gets rid of the wear of rope too commonly occurring upon winding-drums, especially when the coiling is horizontal, that is, upon drums having vertical axes. The troublesome point about Messrs. Fowler's new arrangement is the liability of the ropes to be in the way of "turning the plough at the ends; but this is obviated by keeping one engine "a little forward," and the other "a little backward," so as to hold off the "back rope" or return ply, from passing too closely to the implement. Messrs. Coleman and Morton's engines, with coiling-drums at the boiler side, would be well adapted for the "double-double" plan of working: they already drive two implements at once, meeting half-way, but with a single engine and anchorage.

No. 92. Mr. S. Langdale, of High Espley, near Morpeth, Northumberland (a manufacturer of manures and chemical products at Newcastle, as well as an agriculturist), occupies about 600 acres arable, and 300 of pasture in three farms, High Espley, Low Espley, and Newton Red House; consisting of various descriptions of land, for the most part heavy, but with portions of light soil and gravel. Since August, 1864, he has worked a Howard tackle with 3-furrow plough, cultivator, ridging-furrow plough, and set of harrows, driven by a 10-horse engine. The prime cost, altogether, was about 800*l.*; but no account has been kept of the repairs. In fields averaging about 20 acres apiece, the cultivator does 7 acres per day of 10 hours, and more in a long day, the depth of work 8 to 10 inches; the plough turns over 5 acres a day. The ridging-body has been used with admirable effect in trenching-up cultivated fallows for winter exposure; and the harrows are spoken of as making a really

wonderful tilth for a seed-bed, owing to the depth pierced by the tines and the absence of horses' feet. Indeed, we consider that this steam-harrowing is not taken advantage of by steam-plough farmers half as much as it should be. It is a great mistake to imagine that setting a powerful steam-engine to such a light-surface operation as harrowing commonly is, must be trifling with a huge force—somewhat like putting a Samson to tin-tacking down a carpet or hanging a lady's muslin curtain; for, in reality, scarcely any work of a steam-tackle gives more satisfaction than the harrowing, both from the excellence of its performance and the great area got over per day.

Mr. Langdale's 5 men cost 18*s.* each per week, and his 3 boys 6*s.* each per week; but though labour is dear, coal is cheap—the engine burning half a ton a day, at 7*s.* per ton. A removal is a heavy job, taking 9 horses about 2 hours, the roads being hilly, and the whole of the apparatus having to be moved at one shift from one farm to another. The engine does the "thrashing, grinding, and chopping" for all Mr. Langdale's farms; and, at different times, the tackle has cultivated on six neighbouring farms, doing the work twice over for 21s. per acre.

Mr. Langdale's brother, at Newton Red House, informed us that the land had been levelled before steam culture was introduced, and being well under-drained lies pretty dry, owing to the steam tillage leaving it so light. They have no dead-fallow; always get turnips and potatoes, and have now been enabled by steam to considerably enlarge their breadth of roots. The crops, generally, have been more productive, and Mr. Langdale says, "I find manures to act better": this being precisely accordant with the general experience that artificials give their greatest effect only in finely-worked mould, which cannot be obtained in perfection on strong land except by steam-driven implements. Mr. Langdale formerly employed 27 horses, which he has now reduced to 20, and these are kept at less expense per head.

The tilling-machine is always at work during the proper season, except in wet or bad weather; and its owner is warmly in its favour as an economiser of time and expense, a promoter of the growth of equable crops, and the means of making both clay-land and lighter-land farming remunerative.

No. 93. The Right Honourable Lord Vernon, Widdrington Estate, Morpeth, Northumberland. The old castle ruin at Widdrington contrasts oddly enough with a snug scientific covered-homestall hard by, and with another newly-introduced improvement—a gabled school-house wherein we witnessed a throng of village children "saying lessons" to their mistress and her monitors; and here, in full prospect of the distant Cheviots, gleaming white with a mantle of early snow, we could not

help wondering if this tower had been a fortress of the hero in the 'Chevy Chase' of our childhood,—

> "For Widdrington my heart is woe,
> As one in doleful dumps,
> For when his legs were smitten off,
> He fought upon his stumps."

But whatever the "pluck" of the then owner of this estate, a similar spirit of determined prosecution of an enterprise must be inherited by the present proprietor, who is carrying out great permanent improvements in a most unpromising country. The soil is generally strong, "sticky and mossy," upon a subsoil of strong blue clay,—in some parts yellow clay mixed with sand—but not naturally devoid of fertility, in fact, good wheat-land when the proper mechanical conditions for wheat-growing are provided. Under-draining, good road-making, steam tillage, artificial manuring, and the erection of superior farm-buildings, have altered the aspect of "Houndalee" and "North Steads" farms, including 850 acres of arable; and "Brown's" and "Stamp's" farms are being taken into Lord Vernon's hands, to be put under the ameliorating influences of the steam-plough. This latter holding consists of a poor clay, ploughed two inches deep, in a deplorable condition, and miserably farmed for years, with the last wheat-crop apparently unlikely to yield enough seed for the next. All that we could admire there were the game-fowls, distributed in pairs about the farm, each cock and hen having a field and a "kennel" to themselves—this scattering being necessary to prevent continual "mains" and a rapid mutual massacre of the stock. Under-draining, laying better roads, throwing down fences, and so on, are the preliminary steps of the coming improvement, which will thus be extended over a total of 994 acres of arable and 187 pasture. The land, we should add, lies generally level, and for the most part, in fields averaging 25 acres each.

The first essay here with steam cultivation was made with the "Newcastle prize" "twin-engine" set—that is, two 8-horse Fowler engines, with clip-drums, two plys of rope, and one implement, both engines working "in conjunction" or simultaneously pulling, instead of alternately pulling and resting. This form of apparatus was abandoned, and for these reasons. Instead of working amicably together, the engines used to "clash." The method of stopping and starting was managed in this way—when the plough approached nearly to No. 1 engine, that engine whistled for No. 2 to shut off steam; No. 1 then pulled the plough slowly up and again started it, whistling after the plough had made its first few yards, for engine No. 2 to "join

in." The same process was repeated by No. 2 engine when the plough was at the other end. But so much clock-work nicety of management attended all this, that the men could not work it; besides, it was found that properly, both engines (tied by a rope like Siamese twins) ought to start and stop exactly together, and this could not be attained without electric communication between the two drivers, or rather (it would seem) between the reversing levers on the two engines. Another fault as compared with the "double" or winding apparatus, was that more time was required for removal. Then the engines were considered too light to stand the great sideway strain; for on each alternate journey of the implement, engine No. 1 had to act as the anchorage of engine No. 2, while at the same time engine No. 1 was pulling the plough with all its force. The fore-wheels of the engines were shod with cutting-blade rims which entered the soil, like the discs of a travelling anchor; but, nevertheless, an unfortunate circumstance occurred: owing to the great sideway strain and the want of weight in an engine of this size (8-horse power) one engine broke the pin of its fore-carriage axle-tree, the fore end of the boiler tumbling over one of the wheels on to the ground. However, about an hour and three-quarters sufficed to place it on its wheels again, without further injury. We must not be understood as condemning the "twin-engine" principle altogether, because it is possible that improved mechanical arrangements may make it successful; but the form in which it appeared at Widdrington was not found to answer. As we have said elsewhere, two engines working at once will probably achieve maximum results in steam culture, but with two implements instead of only one.

In April, 1866, Lord Vernon purchased a pair of 10-horse engines with winding-drums—the 4-furrow plough costing 80*l.*; the 7-tined cultivator, 60*l.*; harrows (a light land seed-harrow 15 feet wide, and a heavy harrow 12 feet wide), 50*l.*; porters, 10*l.*; and rope, 84*l.*; altogether, 1040*l.* for the set. There have been no breakages; a few shares have been worn out; but the ropes were defective, and were exchanged for the present good ones, an allowance being made for them by Messrs. Fowler. The daily working expenses are as follows:—two engine-men, 3*s.* 4*d.* each; ploughmen, 3*s.* 2*d.*; water-cart man, 2*s.* 6*d.*; and two boys, 1*s.* 6*d.* each; the men paying their own house-rent. These hands are ordinary farm-labourers, employed at other times on the farms or in the woods. They have found no trouble with the engines and apparatus. Coal, at 5*s.* 6*d.* per ton on the farm, is burned at the rate of about 16 cwts. per day. Oil and tallow cost 2*s.* In shifting, no horses or additional help are needed, and the engines have begun work in a field 1½

mile from the last, within one hour and five minutes from leaving off work in the latter. Mr. Coates, the bailiff, informed us that from April 14th to October 18th, 1866, the work done was 210 acres of digging and ploughing in 29 days—*i.e.*, 7¼ acres per day; 520 acres of cultivating in 48 days—*i.e.*, nearly 11 acres per day; and 391 acres harrowed in 25 days—*i.e.*, over 15½ acres per day; and this harrowing was done twice in a place, the harrow "overlapping half." The engines thrash, and have steam-cultivated 273 acres on 8 farms, at a charge of 10*s.* to 12*s.* per acre, though they will have plenty of work to do without being much let out. Lord Vernon kindly sent us an elaborate statistical summary of costs and quantities, of work done between March, 1865, and October, 1866; but as the 8-horse "twins" were engaged during an unspecified portion of the time, and as the hands employed for several months were "special" men, who did not work on the farm, and received their full wages whether they were steaming or not, the calculations would hardly present fair results. The totals, however, are 524½ acres of digging, 8 to 11 inches deep, in 101½ days, at a total cost of 15*s.* 2*d.* per acre; "repairs" being 42*l.* 7*s.*; and "interest on plant," 126*l.* 5*s.* Of ploughing, 7 to 10 inches deep, 194 acres were done in 30 days, at a total cost of 13*s.* 2*d.* per acre; "repairs" being 15*l.* 18*s.*; and "interest on plant," 39*l.* 17*s.* Of cultivating, 827 acres were done in 93½ days, at a total cost of 9*s.* 3*d.* per acre; "repairs" being 48*l.* 18*s.*; and "interest on plant," 127*l.* 10*s.* And of harrowing, 415 acres were done in 30 days, at a total cost of 5*s.* 1*d.* per acre; "repairs" being 11*l.* 14*s.*; and "interest on plant," 34*l.* 4*s.* The grand totals are 1960½ acres of steam tillage in 255 days (*i.e.*, 7⅔ acres per day); labour costing, 432*l.* 6*s.* 3*d.*; coals, 71*l.* 19*s.* 6*d.*; water, 15*l.*; oil, 41*l.* 8*s.* 4*d.*; repairs, 118*l.* 18*s.* 5*d.*; incidentals, 9*l.* 16*s.* 3*d.*; interest on plant, 327*l.* 17*s.* 4*d.*; altogether, 1017*l.* 6*s.* 1*d.*, or 10*s.* 4*d.* per acre. Lord Vernon's agent, Mr. J. G. Grey, of Milfield, Wooler, has been at great pains to make out the figures; but, as we have said, they cannot be a fair guide for the performances of the present 10-horse tackle in the labourers' hands. We learn from him that, from the 11th of June to the 1st of September in 1866, these latter men accomplished as follows:—49 acres dug, 10 inches deep, in 7½ days; 278 acres cultivated, 10 inches deep, in 32½ days (*i.e.*, 8½ acres per day); and 232 acres harrowed in 17 days. For these 57 days of actual work, 12 days were lost by wet weather, 1 day in repairing, and 1 day in washing out the boilers. The total expenses upon 559 acres of steam tillage were, for labour, 63*l.* 6*s.* 6*d.*; coals, 19*l.* 8*s.* 6*d.*; water, 7*l.* 2*s.* 6*d.*; oil, 6*l.* 10*s.* 8*d.*; repairs, 16*l.* 14*s.*; interest on plant, 50*l.* 8*s.* 9*d.*;

total, 163*l.* 10*s.* 11*d.* The total cost per acre being, for digging, 8*s.* 9*d.*; for cultivating, 6*s.* 8*d.*; and for double harrowing, 4*s.* 2*d.* Mr. Grey does not explain the basis of his estimated "repairs" and "interest on plant." The number of horses usually kept to work this sort of stiff land is a pair to every 12 acres of fallow; and the farm being worked on the 4-course rotation, makes the normal force 26 horses: yet only 12 are now kept, and they lead to the homesteads the harvest of 600 acres, they sow 300 acres of winter corn, and have also been partly employed in carting materials for new buildings and in making new roads. In 1866 as much as 270 acres have been dead-fallowed, all steam-dug in winter, and steam-cultivated twice in spring and summer, some of it three times, to level the surface,—for this stiff clay, when deeply worked, is found to drain well flat. We found a good blade of wheat coming up, upon the steam-tilled land, put in with 3 cwts. of guano per acre; indeed, the only chance for these farms is in thus raising good corn crops, and ultimate profit will depend upon the market and the low cost of the cultivation. And as far as the latter is concerned, the banishment of 14 horses, and consequent saving of 616*l.* a year, will go far towards paying for the steam-work and the artificial manure, which together are converting a few inches of sticky clay into a good staple of twice the former depth. In a few years this estate will present one of the finest examples of improvement mainly secured by steam cultivation.

At the time of our inspection (November 19th) the engines were making first-rate work, in spite of the frost, digging 9 inches deep, with 3 furrows on the 4-furrow implement. We observed the facility with which the signalling is done by the engines whistling, without flags, and the drivers were not at all nervous about pulling up the plough within a foot of the bevel-wheels or the fly-wheel on the engines.

No. 94. Mr. David Wright, of Beal, Northumberland (a farmer from over the Border), occupies 800 acres arable and 300 acres of old pasture, a stiff loam and retentive clay farm on the New Red sandstone, at the extreme north of the county, on he shore opposite Holy Island and within sight of Berwick. he land, with a few stones, but these very small, is ploughed 6 r 7 inches deep by pair-horse teams, at the rate of half an acre day, 3 horses ploughing 9 or 10 inches deep. But these are ry fine strong horses. Mr. Wright formerly kept 32, that used eat "two stacks of hay as long as his barn,"—that is, he had to v for them 100 acres of meadow, but now he mows only 30 r 40 acres. He has parted with 4 (not venturing a greater eduction at present, as he grows 100 acres of potatoes, besides urnips, with no dead fallow, and pipes have yet to be carted for

the underdrainage not quite finished); and his 28 horses, no longer requiring to be so highly kept, are now fed on wheat-straw and bruised oats. We saw them in the best cart-horse stables we have met with, fitted with racks, and slab bottomed mangers, with ample air space overhead, and a 3-yards-wide walk behind the horse's tails.

A Fowler plough having been tried here in 1862, led Mr. Wright to proceed vigorously with the work he had already begun, of preparing for steam tackle of his own, by clearing away fences and a few bits of old copse, full of vermin, striking out new roads, and making his fields to average 40 and 50 acres each, some of them being 80 acres in extent. And this he was enabled to effect, with the consent and co-operation of an exceedingly good landlord. A Fowler 14-horse set, with anchorage, 4-furrow plough, and 7-tined cultivator, was bought in July, 1864, costing 950*l.* "Additions" have cost 30*l.*; and repairs, partly from breakage, and partly from tear and wear, have amounted, in all, to about 20*l.* per annum. Two years of solid work have thus involved no "expense" of consequence, and none of the rope has yet been replaced,—they have had more trouble with the "eyes" of the rope than with anything else. This unusual economy in the wear of rope may be accounted for partly by its being of peculiarly hard steel (for wire-ropes vary much in quality), and partly from the circumstance of its being in thoroughly business-like hands. For, seeing the tackle at work, we observed that the portering was extremely well done by 3 boys, the rope held completely off the ground and not carelessly suffered to grind diagonally over the porter friction-rollers. The rope appeared to be nearly "half-worn," and this after 1500 acres of work, every bit of it deep and heavy tillage. We noticed that the hands (who are all ordinary farm-labourers, at other times employed in the common details of the farm), have arrived at such smartness of procedure, that the time lost in turning the plough was only 20 seconds at the anchor end, and 30 seconds at the engine end, the driver firing and looking sharp round at the same time. The trouble which some parties have met with from the "slack-gear" on the implement, has not been found here, partly owing to the absence of land-fast stones, (indeed there are few stones of any kind,) which generally cause most of the mischief. Mr. Wright is quite satisfied with the single-engine system, as the slack-gear allows for variations of 20 or more yards' length of furrow in a field, without stopping to add or take off sections of rope, and the anchorage headland is scarcely injured. The engine headland, however, is in bad plight, and has to be ploughed up by a 3-horse team, when it is not a grass road or a hard metal road, as in the majority of cases it is on

this farm. The double-engine system would require twice the extent of these turf or other roads, and would spoil so many headlands. However, this objection we believe is trifling, in comparison with the time and expense saved in shifting, and the general celerity in working of the "double" system. Mr. Wright never works up a corner or a headland by steam; and where a fence is very "angular," instead of parallel with the opposite side of the field, instead of running the anchor alongside it, he directs it "square" across the field, completing the remaining "gore" or angle, by horse labour. This course avoids hindrances and changes; and straightforward continuous running is one great desideratum in steam-ploughing.

Removal occupies four hours up to half a day, with a pair of horses and extra man. The engine-man has 3*s.* 6*d.*, the ploughman 3*s.*, anchor-man 2*s.*, three porter-boys 1*s.* each per day; and the boy and horse with water-cart may be put at 5*s.* The ponds and ditches are convenient for supply. About 16 cwts. of coal are consumed, at 10*s.* per ton, and oil costs 1*s.* 6*d.* a day. The engine ploughs 8 to 10 inches deep, 7 acres per day; digs 12 inches deep, 5 acres per day; and grubs, at the great depth of 16 inches, 12 acres per day. This profound culture is paralleled by Mr. Hawking, near Borobridge (See No. 89), but in his case, the 14-horse engine manages 9 acres a day at 16 inches depth. Before he became a steam farmer, Mr. Wright never could put more than 12 horse-ploughs to work at one and the same time, and at 7 inches depth, they turned over 6 acres a day. He can work the same number of ploughs now, in a pressing season, while the engine is doing 7 acres, too; so that, in effect, he has doubled his tilling power, or, in other words, double the extent of land is ploughed in a day. And the steam work is more equable in depth; for though some of the ploughmen make good honest work, some of them always shirk their hard holding of the plough-handles, and ease their teams by scamping the tillage.

After steam culture the land (under-drained 3 and 4 feet deep) dries better and sooner, though root-crops are never attempted to be fed off. Mr. Wright finds the digging to be "first-rate" for beans, the seed-tilth so soon coming into condition in spring, from the absence of horses' trampling, that the beans are got in earlier than they otherwise could be. Stubble is steam-dug in autumn or early winter, lies rough and open, and not pressed; and in spring is found to dry "a whole fortnight" sooner than horse-ploughed land. The rough tilth is torn down by grubber-harrows worked by horses, immediately before drilling the beans. Mr. Wright considers that as much benefit is thus derived from the steam tackle as he gets in any other part of its performances;

the earliness of sowing and the absence of "concealed horse-foot-prints" being so important. He thinks that the steam harrows would not be an improvement upon the horse grubber-harrow, from the difficulty of working the many porters in a single-engine set, upon land "so tossed about that it stops all the fox-hunters without calling out." We saw a piece of bean stubble steam-ploughed for wheat, splendidly done. The sowing is done broadcast with barrows, for here they are not much annoyed with "annuals." The potato land is also ploughed by steam for wheat.

The preparation for turnips is to steam-dig in the autumn, and twice grub in the spring, the rest of the seed-bed being wrought by horses; and, as an extraordinary advantage of possessing a doubled tillage force, Mr. Wright never has more than 2 acres prepared a-head of the turnip sowing, the seed thus going into as moist a mould as possible. His swedes are good; but much of the plant missed; the land tolerably clean. He has not had sufficient time to compare his produce before and after "steam;" but says, "one thing is very obvious, the crops are much easier kept clean, and that of itself should help them to yield more." He has not altered his rotation or enlarged his breadth of root-crops.

The engine does nothing but tillage-work on this farm; for it cannot be spared to visit other people's occupations, and a 10-horse portable, with a Clayton portable thrashing-machine, does all the thrashing at the main homestead and at an off barn, besides grinding, chaff-cutting, root-cutting, oat-bruising, sawing wood, and other occasional labour.

Having reached a point so far north, we ventured to extend our tour, on the kind invitation of Mr. Hope, to see what steam culture is doing in the renowned district of East Lothian: for if tillage-husbandry so perfect and so economical as that of the best farmers there should be improveable by steam machinery, what a convincing proof this would be that second-rate farming is open to still greater benefit from that machinery.

Within a few miles of Drem, in Haddingtonshire, five sets of steam-tackle are at work. We had not time to visit Mr. Walter Reid of Drem—whose apparatus is that of Messrs. Coleman and Morton, of Chelmsford, in which a headland engine with a couple of winding-drums works two one-way implements, these being always in work when going toward the engine, and returning toward the anchor backwards without working. It was reported to us as giving him satisfaction in every way. We were also obliged to pass by the Fowler "set" of Mr. Todd, of Castle Mains, Dirleton, near Drem.

Mr. Hope met us at Drem Station, on Saturday morning, November 17th, our first call being upon

No. 95. Mr. Thomas Begbie, of Queenston Bank, Drem, Haddingtonshire, who has worked a 14-horse Fowler engine since 1862. His farm is on the trap rock; the soil partly light, but portions making heavy pair-horse ploughing. He uses the 6-feet cultivator for autumn and spring tillage; does all the heavy work for turnips, and prepares some of the seed-furrows for wheat, by the steam tackle. The main advantages found are in the greater expedition and the increased depth of the work, as compared with horse-ploughing and grubbing. Mr. Begbie considers that his root crops show a considerable augmentation of produce, though he has not tested steam against horse work in the same field. One palpable result has been attained—the displacement of one-fourth his former number of farm-horses.

Our next call was upon

No. 96. Mr. William Sadler, of Ferrygate, Dirleton, near Drem, Haddingtonshire. Eastward of Drem, and not far from the new "watering-place" of North Berwick, Mr. Sadler occupies 409 acres of arable mixed soil, lying in 50 and 60-acre fields, on a gentle rise of bleak unwooded country, which looks northward over the wide Firth of Forth.

A Fowler 10-horse engine was tried here in 1862, but, wanting in power, was changed for a 12-horse engine, which has done all the heavy work for roots, and also ploughed the land for wheat, barley, and other crops. And now the big boulder-stones have been got out, Mr. Sadler finds that he can accomplish his steam tillage for much less than the price that horse-work used to cost, and his former force of 14 horses has been reduced to 9; a fact from such a place and from such an authority as should tell more in favour of steam culture than a dozen reports from ordinary practitioners. We walked over some magnificent tilths, torn up 12 or 14 inches deep; and when Mr. Sadler declared to us that not only was his tillage-expenditure so much less than formerly (and this, remember, under the best Lothian management of teams which has become proverbial for its exactness and rigid economy in every detail), his crops were also better, we could readily recognise the correctness of his judgment on this point; for we never beheld more wonderful swedes and hybrid turnips than those which, in huge bulbs for hundreds of yards together along the rows, had just been pronounced by a local Society's official judges to weigh 30 to 36 tons per acre.

Another important circumstance is that Mr. Sadler, feeling the loss of time involved in taking-up and setting-down the anchor, and the difficulty of the action of the "slack-gear" in fields not perfectly rectangular, has purchased a "double-engine

set." Of course this tackle (which we believe has made a good beginning since Christmas) will do duty on several other farms besides Ferrygate.

No. 97. Mr. George Hope, Fenton Barns, Drem, Haddingtonshire, occupies 670 acres arable, with 2 only of old pasture; a medium loam-soil, in places more clayey. High-backed lands were at one time adhered to; but in the early days of under-draining the farm was tile-drained at 2½ feet depth, and flattened, and now it is always sufficiently dry. A Howard apparatus, with 10-horse engine, was purchased in September, 1863, has done more than 1200 acres of tillage since that time, and, excepting the rope, appears as sound and good as ever, and has incurred no expense in repairs. All the work has been grubbing,* and in consequence of this aid all operations are so forward in autumn and in spring, that Mr. Hope "wonders how he ever got on before." He has parted with three horses, and would be able to sell off more, if he had not so much carting of potatoes, besides a new farm, distant 2½ miles, at which many improvements are being made. He finds that he can do a 30-acre field at one setting down, and by simply turning the engine and windlass round, does 60 acres from one position. All his steam-work is done with inferior coal, costing 10*s.* a ton with the cartage.

Mr. Hope considers that he is well repaid for his investment by the deeper and better tillage, and by the winter-exposed land being sooner ready for sowing in spring. Then the yield of cropping is greater, from the fact of the crops being more equal. This is due to the more timely sowing; instead of having some fields too early and others too late. Mr. Hope's root-crops are "a treat to see," and every square foot of ground wonderfully clean, the turnips growing up to the very stems of the quick hedges; and there, instead of weeds and grass, rape shoots out from the hedge-bottoms. The hedges are cut once a year, and the bottoms dug every time a crop is put in.

It was not part of our embassy, however, to make notes of Scottish husbandry; we had simply to form an impression as to the value or uselessness of the steam-plough on farms where everything had been about perfection already; and the impression we brought away with us is, that the heavy investment of a steam-tackle is found to pay well even upon the neatest and best-managed occupations where first-class farming has been practised for generations.

Particulars of Farms in the "North" Division:—

* Since the visit of the Committee, Mr. Hope has purchased a Fowler's 4-furrow balance plough, which he works with his Howard's apparatus, and finds lighter in draught than the cultivator. He can now easily and certainly regulate the depth of the work; this he formerly failed to attain where strong clay and sandy soils alternated in the same field.

Reference No. of the Farm.	Acres Arable.	Nature of Soil.	Apparatus.	Horse-power of Engine.	Acres Ploughed per Day.	Total Cost per Acre.	Acres Cultivated per Day.	Total Cost per Acre.	Total Yearly Cost of Steam Tillage.	Reduction in Number of Horses.	Number of Horses now kept to each 100 Acres.
87	280	Strong loam	Fowler	14	..	..	..	..	..	14 to 10	2⅔
88	300	Strong loam	Fowler	12	4 to 5	..	20	..	..	14 to 8	2⅔
89	225	Loam and clay ..	Fowler	14	6	..	10 to 12	..	..	12 to 8	3
90	700	Strong land	Fowler	10	..	..	7½	..	..	..	..
91	450	Strong loam	Fowler	Two 10	7⅔	..	12⅔	..	..	18 to 12	2¾
92	600	Heavy and light ..	Howard	10	5	..	7 to 9	..	..	27 to 20	3⅓
93	994	Clay..	Fowler	Two 10	7	..	8½	..	..	26 to 12	1¼
94	800	Loam and clay ..	Fowler	14	7	..	12	..	..	32 to 28	3½
95	..	.. ..	.. ..	..	..	..	..	..	..	..	..
96	409	Strong soil	Fowler	Two 12	..	..	..	..	..	15 to 10	2½
97	..	.. ..	.. ..	..	..	..	..	..	..	..	..

SECTION III.—PARTNERSHIP.

Under this head we class examples of the joint-ownership of apparatus by two or more farmers, excluding partnerships and companies which merely "let out" or undertake work by contract. And we take, first, those cases in which two persons unite in the proprietorship and use of one set of tackle.

No. 98. Mr. Newton, of Campsfield Farm, Kidlington, near Woodstock, Oxfordshire, occupying over 500 acres arable, under the Duke of Marlborough, and

No. 99. Mr. Thomas Taylor, of Shipton-on-Churwell, occupying the adjoining farm of 750 acres arable, are co-partners in a steam-plough tackle. This is one of Fowler's separate-windlass sets (on Eddington's principle), in which a 10-horse power Lincoln portable is run bodily up (road-wheels included) on to the top of a carriage-frame, within which is a clip-drum driven by gear-work and an endless block-chain (in place of a belt) from a V-grooved rigger on the engine crank-shaft. Hauling the engine up incline-beams by means of the wire-rope and gearing of the windlass-frame, or again lowering it to the ground, takes half an hour: the whole affair, when the engine is mounted, being self-travelling. There is a self-travelling anchorage, with the rope and implement, porters, &c., as in other Leeds tackle; and removing the whole occupies four horses about two hours.

The greater portion of the two farms consists of stone-brash land; not very light, but loam containing such an admixture of lime and clay as to be sticky, never keeping plough mouldboards bright except when thoroughly dry,—or as it is termed here, "drought-rotten." It is heavyish pair-horse ploughing; or, as a man expressed it in the forceful but unsmoothed Saxon of the locality, "turnin over an acre a day gives tew hosses a deuce of a buckin." A staple six inches deep, in some places deeper, lies directly upon the rock,—or rather, upon the thin "kale" stones or rubble ("brash"), which are brought up in plenty by the deep-searching tines of the cultivator. The consequence of this "breaking of the pan" is that water gets down much more quickly; the drainage has been made perfect (though it is not the whole of the land that is well-drained). And again, as we should naturally expect, the horse implements work much more easily. The only steam implement used is the 7-tined balance cultivator; with which the 10-horse engine can do 12 acres a day, at 8 or 9-inch depth,—though it is to be noted that this depth was not attained the first year. As an average day's work, including removals, 9 acres will be near the mark; a good long day's work is 10 to 12 acres, but occasionally a stoppage may occur, and only 4 acres may be done. The greatest area

cultivated in one day was 15 acres, on Mr. Taylor's farm. The engine burns about 10 cwts. of coal per day, at 15*s.* per ton. The engine and windlass-man (for this extra hand is requisite with this form of apparatus), have 7*s.* a day between them; the anchorman and ploughman 2*s.* 6*d.* each; and two porter-lads 1*s.* 4*d.* each. No exact account has been kept of the expenses and performances during the 4 years' employment of this apparatus; but nothing very serious has been met with in repairs, and the most important item, wear of rope, is as follows:—Messrs. Newton and Taylor have cultivated about 1200 acres in the last 3 years: the rope, 3 years old, is still in good condition; and yet this is very stony "grinding" land, and all the work has been first breaking-up, that is, the cultivator has done no crossing of already tilled ground. Absolute proof in figures was not adduced, but Mr. Newton declared his belief that the steam operations are of cheaper cost than horse work; and he highly values the machine as an auxiliary helper-forward of the general tillage labour of the farm, as well as for numerous other direct and collateral benefits. Clearly, the already-mentioned easing of the passage of the horse implements through the soil and its loosened stones, is not the only gain; for Mr. Newton has reduced his previous team from 19 down to 13 horses, and Mr. Taylor has dispensed with no fewer than 20 oxen. Here, then, we have 6 horses and 20 oxen displaced by a 10-horse-power steam-engine; yet the work declared to be better, easier, and forwarder in season,—the apparatus being most of all prized, we were told, because of the power it conferred of "getting on with work." Yearly expense of draft oxen is such an indeterminate quantity that (as intimated in our Introduction) we can scarcely venture to fix a money value upon the saving here effected; but if we may say 15*l.* per bullock (of course including men, implements, and every item of outlay), this, together with our assumed datum of 44*l.* per horse, will make the whole sum 564*l.*, to be put on the credit side of the steam account. Judging by the partial details afforded, the "steam" working expenses, including labour, removal, water, oil, wear of rope, and petty repairs, can scarcely exceed 40*s.* to 45*s.* per day, which, at 9 acres a day, will be under, or not exceeding, a crown per acre. The cost price of the apparatus, with two ropes, a new one and an old one, was 516*l.*; the engine, belonging to Mr. Taylor, may be put at 270*l.*, or 786*l.* altogether. The interest at 5 per cent., on the whole, will be 39*l.* 6*s.* a year. Deducting the value of rope and other wearing parts, we may reckon 5 per cent. "depreciation" on say 650*l.*,—that is 32*l.* 10*s.* a year; the two items amounting to 71*l.* 16*s.* This divided between 400 acres of work done in a year, gives 3*s.* 7*d.* per acre; the total cost per

acre thus coming to 8*s.* 6*d.* And allowing for heavy repairs, we cannot see how the total outlay can exceed 10*s.* an acre, or 200*l.* a year,—unless it be through unusual breakages and queer accidents. Besides, we have made no allowance for the use of the engine in thrashing; and, though we did not make a note of this point, we believe that it is so employed for a considerable part of the year. Setting off this annual cost of steam tillage, against the saving by displacement of teams, we have a clear gain of (564*l.*—200*l.*) 364*l.* *per annum.* This precisely agrees with what Mr. Newton affirmed to be his "impression" (for book-accounts, and a balance-sheet for comparison, have not been kept), that the steam work has been cheaper than the former horse work. It is: and our reckoning would lead to the conclusion that, after squaring all its own working and other yearly expenses, the tackle is paying for itself over and over again about every two years.

It is remarkable that an apparatus of low capability, "cultivating" only, and doing the small proportion of but 400 acres a year upon a joint area of 1250 acres arable, should have been able to displace one-third of the old force of draft animals,—that one 10-horse portable should have proved its ability to make better tillage and bring heavier crops than could be got by the use of 6 horses and 20 bullocks. Readers will perceive that the nature of the farms has a good deal to do with it: the land is of such a medium character that autumn-cleaning and enough other work can be well done by a form of apparatus not so well adapted as the regular "Leeds set" for economizing motive-power; so that the yearly sum sunk in interest and depreciation is not particularly heavy. Then further, the husbandry pursued under (what is still more important) a thoroughly business-like and energetic management of both teams and labourers, has enabled these farmers to part with a large percentage of their former force of draft-animals, notwithstanding that much less steam work is done here than on many other farms where the engine ploughs and digs, besides grubbing: this example teaching that many followers of steam tillage retain more horses than they actually need. But particular attention should be directed to the circumstance here exemplified,—the difference between a banishment of draft-animals by a set of steam-tackle, and the same displacement (as here) *by only half a set.* For had Mr. Newton and Mr. Taylor bought a "set" each, they could have sold off no more horses; and just the same amount of yearly saving on each farm would have been counterbalanced by double the present burden of interest, &c., upon first investment. The very favourable balance on the side of steam culture, in this case, has mainly resulted from the circumstance

of two large occupiers joining in an apparatus which, though of moderate first cost, was equal to their particular need, and powerful enough to do as effectual service on their light or medium soil, as more costly machinery on other land. Have we made our meaning plain? The inference is, that, under such circumstances, the partnership of two farmers makes an extraordinary difference in the formidable matter of starting the steam-horse: only they must be careful to agree. Mr. Newton and his neighbour manage very well as yet, we believe, with only "a mutual understanding:" no bargain binding either of them to time, or acreage, or "first turn."

Let us not be misunderstood as recommending "cultivating" alone, even on farms like these, or as implying that a more powerful and capable machine, ploughing and executing all the heavy tillage, would not have answered still better. The case is simply stated as it appeared to us; and though very satisfactory as it stands, quite possibly it might be improved upon. At any rate, there are cases in which a "steam farm" of 530 or 750 acres arable cannot spare its tackle to do the work of a second farm of like size.

Our observations upon the husbandry at Campsfield may be briefly written. The fields, of large dimensions, have boundaries convenient for steam culture, with little timber spoiling the neatly-kept fences. Mr. Newton farms on "the 4-course;" and showed us one of the best "turnip breaks" seen in all our excursion,—the earliest-sown swedes a little damaged by fly,—the best field of swedes grown upon land horse-ploughed 7 inches deep, and dressed with superphosphate and leather-dust manure. Artificial manure is pretty heavily used here; for, as we are told, this sort of land "wants warming." We saw another grand piece of swedes, for which the seed-bed had been steam-tilled in the middle of March, from a wheat stubble; the roots are grown with artificial, but no farmyard manure. For fallow-crops, however, the usual plan is to smash up the wheat stubbles 7 or 8 inches deep, any time between harvest and the 1st of February. The turnip layers are horse-ploughed for barley. Part of the seeds is horse-ploughed for wheat, and part steam-cultivated for wheat. This must be cautiously done; for once, a piece of clover on Mr. Newton's farm, turn-over ploughed by steam for wheat (he says), looked like yielding 5 or 6 quarters per acre; but just before ripening, all went down, and the produce was bad. The ploughing was too deep, and the bottom not firm: the depth should not have been more than 5 inches. The effects of the steam tillage are summed up thus:—"The land drains better; the root-crops are better; and, as a consequence, the barley, and indeed all the corn-crops, are better." This ground always is

a good winter layer for sheep; but the deeper tillage has made it still better for them—drier instead of more spongy, as observed in some localities. In spite of the comparatively moderate area steam-worked in a year, and the great diminution in the force of horse-flesh (and ox-flesh) kept, we considered Campsfield Farm one of the cleanest and best-managed we have walked over, and the crops are plainly so good that the land would well bear "a little more doing at," and a 5-course rotation might be adopted with good results.

No. 100. Mr. Samuel Druce, of Abbey Farm, Eynsham, and, No. 101, Mr. Joseph Druce, of Twelve-Acre Farm, Eynsham, Oxfordshire, are partners in a steam-cultivating apparatus, upon a joint-occupation of 700 acres arable, consisting of Oxford clay upon a subsoil of solid yellow clay (in which the drains lie), and a small proportion of more loamy land having a subsoil of boulder-gravel. The 4-course shift is the basis of the management, with a considerable portion of bare fallow. The old style of tillage, before the introduction of "steam," was ploughing 4 or 5 inches deep by 3-horse or ox teams. The force formerly kept was, on Mr. Joseph Druce's farm, 17 horses and 8 oxen, the latter consisting of two 3-ox teams, with a spare bullock to each; and on Mr. Samuel Druce's farm, 12 horses and 4 oxen; making a total of 29 horses and 12 oxen. "Steam as an adjunct" has effected such a reduction that Mr. Joseph now keeps 14 horses, and Mr. Samuel 9 horses, that is, 23 horses altogether, and no oxen at all. And this banishing of 6 horses and 12 oxen has been, probably, the largest advantage of steam cultivation here. A Smith's 4-wheeled windlass, a 3-tined and a 5-tined grubber, and, we believe, an 8-horse engine, were purchased in 1860; and the work done on Mr. Joseph Druce's farm has been about 150 acres in each year. We do not know how much steam-work has been done altogether. In the spring of 1863, 70 acres were grubbed a first time, 7 to 11 inches deep, and 70 acres a second time, in the space of 20 days, including five removals. The coal burned was 8 to 10 cwts. per day, at 14*s.* per ton; the oil used was nearly a quart per day, costing 6*s.* 6*d.* a gallon; and the 5 men and 3 boys employed cost 15*s.* 2*d.* per day. This is all the record that has been preserved of the expenses and performances: and we can say nothing as to repairs, beyond the fact that the present rope which we saw is about half worn through. The rate of work, we were informed, varies from 4 or 5 up to not more than 6 or 7 acres per day; some of the ground being very tenacious, while in other places the implement "skims the rock" at 3 to 4 or 5 inches depth. Unfortunately, both the Mr. Druces were from home at the time of our visit, and we did not learn to what extent they

consider the apparatus valuable: but the bailiff was evidently not in love with it. There has been a saving in the outlay for team-work amounting according to our assumed standards of 44*l.* per horse and 15*l.* per ox to 444*l.* This is a great point, for the whole cost of steam cultivating probably does not exceed a fourth of this outlay. The effect of steam culture upon the land, the management, and the cropping, was not so striking as we have found it in some other cases; but still, the apparatus must have been a source of very considerable profit on these farms. That the simple forwarding of operations, and so on, must have been highly advantageous on such land as this, everybody will at once understand. However, steam cultivation on strong land greatly varies in degree. A steam-tackle delights you or not, like Uncle Tim's flute, "accordin' how you work it;" and very probably, had Mr. Smith, of Woolston, this identical sort of clay, &c., under hand, he would show his winter tilths all in 3-feet trenches, open to the atmosphere to an amazing depth, with tremendous crops sure to follow, and no fear whatever of spoiling the staple by picking the lock of the "unknown country" beneath.

No. 1[illegible]2. Mr. William Bulstrode, of Mount Farm, Cookham Dean, near Maidenhead, Berkshire,—occupying 3[illegible] acres arable and [illegible] of pasture,—is partner in a steam-tackle with a neighbour, Mr. J. M. Gurney, of P[illegible] Farm, Cookham, holding a farm of similar size. The surface undulates, being in some parts rather "hilly;" and the fields range from 6 to [illegible] acres each, with no alterations of fences, or roads made for the accommodation of steam-power. A portion of the land consists of sharp gravel, part of loam on a chalk subsoil, and part of very stiff clay.

In May, 18[illegible], a Clayton and Shuttleworth's 10-horse power [illegible]-cylinder portable engine was purchased, at a cost of 300*l.*; with a H[illegible] tackle,—including windlass, 1760 yards of steel rope, [illegible]-tined cultivator, a set of drag-harrows, 10 extra porters, 4 extra snatch-blocks, and 4 extra anchors,—which cost 253*l.* 10*s.* Thus the whole investment was 55[illegible] 10*s.* During the [illegible] years the apparatus was let out [illegible] hire; but [illegible] abandoned, owing to the exc[illegible] travelling about and in [illegible] that farmers had [illegible] than they would have [illegible] had been adhered [illegible] porters, snatch-bl[illegible] or [illegible] a [illegible] and inv[illegible] liable [illegible]

dental hindrances to working have been merely nominal. The principal breakages which have occurred are these:—Bursting off windlass-drum flanges, and breaking the windlass-pinion cogs, which parts are now made stronger. Snatch-blocks, too, were at first broken through careless mismanagement, which hardly ever happens now: breaking of the rope sometimes occurs—depending partly upon the management and partly upon the quality of the rope. The destruction of rope is an item not easily determined. In February, 1864, a length of 1400 yards of new rope was purchased; but 600 yards of the old were still kept in use, and are working now. It would appear that (1760 − 600) 1160 yards of rope were destroyed in the first three years. Of the total length purchased, namely, (1760 + 1400) 3160 yards, the remaining 2000 yards are still so good that Mr. Bulstrode does not expect to want any new rope for one or two years to come.

Up to May, 1866 (that is, five years' work), 2137 acres had been cultivated, at an average depth of 8 inches, and greatest depth 13 inches, and 464 acres had been drag-harrowed; and if we take 2 acres of this harrowing as work equivalent to one acre of the grubbing, the total acreage may be stated at 2369 acres. Upon this performance the wear of rope has been 1160 yards worn out, *plus* a proportion of damage to the 2000 yards remaining. If we may say, one-half the use of the 2000 yards is chargeable upon the five years' work, the 2369 acres of work will have consumed (1160 + 1000) 2160 yards of rope, which, costing 94*l.*, makes the sum per acre about 9½*d.* However, Mr. Bulstrode says, "The wear and tear of rope, when I first had it, was fearfully great, owing to the tackle being out on hire; I therefore think that, for home work, and with proper care, a charge of 6*d.* per acre for rope will about cover the cost."

(100*l.*) at 10*d.* p acre, and rope at 6*d.* to 9½*d.* per
amoun to 1*s.* 4*d.* or 1*s.* 7½*d.* per acre.
yed to do the farm thrashing, an
lculating interest and depreciation.
nt., on say 450*l.*, and depreciation
this will be, for the two items, in
er acre. Thus the cost due to the
repairs) will be 3*s.* to 3*s.* 3½*d.*

All the hands are ordinary
are 12*s.* a week. But the
(it being folly to run short
that requires no rest); the
end in getting up steam.
y; ploughmen and windlass-

men, 2*s.* 6*d.* each; two anchor-men, 2*s.* 3*d.* each; two porter-men (not boys), 2*s.* 3*d.* each (though in short fields one porter-man is sufficient); and one man with the water-cart, and engaged in oiling, &c., 2*s.* 3*d.*, or 19*s.* 3*d.* altogether. Then, each man has 3 pints of beer, or 3 gallons for the gang, at 2*s.* 6*d.*; making the total labour per day 1*l.* 1*s.* 9*d.* The horse, carting about 900 gallons of water from a spring at the homestead, costs 2*s.* 6*d.* Moving takes 8 horses, and the regular steam hands, for two hours; or sometimes 4 horses for a longer time, generally about every third day—say, the cost of horses, 1*s.* 9*d.* upon each working day. Two pints of oil cost 1*s.* 3*d.*; and 11 cwts. of coal, at 18*s.* a ton, cost 9*s.* 11*d.* per day. The expenses are thus 1*l.* 17*s.* 2*d.* per day.

Howard's cultivator, generally taking about 3 feet breadth, will take more than 4 feet breadth when the 5-tines are worked with wide shares on; and with an average depth of work, 8 inches (the greatest depth is 13 inches), and the engine moving with 60 lbs. pressure, it does 9 acres a day. The drag-harrows (two being generally used), under their exceedingly light steerage-frames, accomplish 20 acres per day on an average. The following are the particulars in Mr. Bulstrode's "steam-cultivating journal":—

"Summary of work done in 1865—

	Acres.
Cultivated, first time	102½
" second time	179
Drag-harrowed by steam	48
Total	329½

Number of removals 16
Number of days' work 40

Therefore the number of acres per day, including removals, is $\frac{329\frac{1}{2}}{40} = 8\frac{1}{4}$."

"The summary of spring work done in 1866, is—

	Acres.
Cultivated (but not first time)	133
Drag-harrowed by steam	91½
Total	224½

Number of removals (including the first setting-down) 8
Number of days' work (including removals) . . 24

Therefore the number of acres per day, including removals, is $\frac{224}{24} = 9\frac{1}{3}$ acres. And the number of acres per day, exclusive of removals, is $\frac{224}{22} = 10\frac{1}{4}$ acres."

When we know that, during part of the year 1865, Mr. Bulstrode had not adopted certain improvements (to be mentioned presently) which now accelerate his speed of working; and that some time was taken up in experimenting upon the said inventions, we may fairly put the present rate of performance (including the breaking up of whole ground as well as spring crossing) at an average of 9 acres per day. Hence, the average cost of the steam-work is 4*s.* 1½*d.* per acre for working expenses, and 3*s.* to 3*s.* 3½*d.* per acre for the machinery, making a total of 7*s.* 1½*d.* to 7*s.* 5*d.* per acre.

To put the pecuniary statement of the case in another way: the apparatus was engaged for 79 days in 1861; 87 days in 1862; 46 in 1863; 68 in 1864; 40 in 1865; and 24 up to June, 1866—being much hindered by wet weather in the spring of 1866, but not much in the other years. But on Mr. Bulstrode's own farm the average number of days' work is 35 days of cultivating and 4 of drag-harrowing, or 39 days per year. The working expenses being 1*l.* 17*s.* 2*d.* per day, the yearly outlay will be 72*l.* 9*s.* 6*d.* Add interest and depreciation, 40*l.*; repairs, 20*l.*; and rope (94*l.* for 5 years ÷ 5) 18*l.* 16*s.*, and we have the total annual outlay upon steam tillage, 151*l.* 5*s.* 6*d.* Mr. Bulstrode has reduced his teams from 13 to 8 horses; the displacement of 5 horses, at 44*l.* each, saving 220*l.* a year.

Mr. Bulstrode's neighbour (having worked the tackle only in autumn, at least not in spring) has sold off only 3 horses, so that the total annual saving in draft animals effected by the steam-tackle is 8 horses at 44*l.*; or 352*l.* The whole yearly outlay being 151*l.*, the nett gain must be 201*l.*

This is not a small gain, when we consider that it is saved not merely with the same tillage as before, but that the staple soil is now regularly worked to a depth of 8, instead of 5 inches.

Mr. Bulstrode has not altered the course of cropping upon his farm, which includes one-fifth under roots; but he reports a larger produce from steam cultivation, partly due to increased depth of tillage; chiefly, however, to greater cleanliness of the ground. His practice generally is to stir land four times in preparation for a root-crop, and the farm is certainly in a tidy condition.

A word or two must be said upon the partnership in the steam-apparatus. The arrangement is this:—all expenses for repairs are divided equally between the two partners; a certain sum is agreed to, to be charged daily for wear and tear (say at 20 per cent. per annum on prime cost), and whoever works the tackle the greater number of days is charged that sum multiplied by the difference in the number of days.

Mr. Bulstrode has turned his mechanical taste to good account

in expediting the action of his machinery. And his several ingenious appliances, though apparently small in themselves, so materially affect the results in the two important matters of "work done per day," and "cost of repairs per acre," that they are worthy the serious attention of all persons employing the stationary-engine system. Perceiving that a large percentage of time was lost every day in the mere delay of the implement at each end of the field, he devised the "patent snatch-block slings," which require no further description from us in this place than an intimation of their use and purpose. Instead of being knocked-off from one anchor, and, with difficulty to the anchor-man, hooked-on to the next, the patent pulley slides of its own accord along a strong iron bar to its place at the next anchor, and does this not while the implement is waiting at the end, but while the implement is in work on its way back again. In our account of Messrs. Howards' farm (No. 51) we record that only 7 or 8 seconds were observed by us to be spent between pulling-up the cultivator and starting it again, by help of these slings; this was when worked by Messrs. Howards' skilful men. Mr. Bulstrode's labourers we timed to be from 9 to 12 seconds in "turning at the ends." Mr. Bulstrode has drawn up the following comparison between this and the practice with the old pulleys:—

"1st. Nine acres can be cultivated per day, where only 8 acres could be done previously;

	Seconds.
Say, the average time of traversing a field is $2\frac{3}{4}$ minutes	165
Average stoppage at the ends was	35
Total	200

The average stoppage when the sling is used is 10 seconds; and the time saved at each end is $35-10=25$ seconds. And as $25 : 200 :: 1 : 8$, therefore $\frac{1}{8}$th of the whole time is saved. Or, in other words, 9 acres are done in the same time as 8 previously.

"2nd. The saving in labour in the cost of porter-men—no longer required to assist the anchor-men—may be fairly put at 2*s*. per day.

"3rd. The reduction in cost will amount to 40*l*. per annum on a farm of average size. In this way, if the previous cost of cultivating per day was 50*s*., the cost per day with the slings will be 48*s*. The previous number of acres per day having been 8, the number of acres with the slings will be 9. Hence—

	s.		*s.*	*d.*
The cost per acre, without slings, is	$\frac{50}{8}$	=	6	3
The cost per acre, with slings, is	$\frac{48}{9}$	=	5	4
Saving per acre			0	11

Say, saving 1*s*. per acre, or 8*s*. per day. On a farm providing 100 days' work, or 800 acres of steam tillage in a year, the saving is 40*l*."

We commend this little bit of arithmetic to occupiers of small fields, and ask them how they can possibly get the full profit out of a steam-apparatus until their landlords enable them to grub-up the hedgerows now preventing the implement from making 400-yard-long instead of 200-yard-long furrows? For if it be so important to shorten the time spent in "turning," how much more important it must be to lessen the number of "turnings" required in a day. Even Mr. Bulstrode's "10 seconds" at the end are one-tenth of the time occupied by a journey of the implement; that is, out of 11 hours in the day, one whole hour is lost in making the tool ready for its actual work. Suppose, now, his average field to be doubled in length, stoppage at the ends would be only one-twentieth of the whole time, and another half-hour's work, or nearly half an acre more, would be won in the day without the expenditure of another halfpenny in expenses. But, on the other hand, if the field were of half the length of Mr. Bulstrode's field, then the number of turnings would be double, the time wasted would be one-fifth, or more than two whole hours out of the day, with more than one acre less done per day; or, in other words, the work would cost probably a shilling or 1*s*. 6*d*. per acre more. It is worthy of note that precisely the same operation upon the self-same soil may be made to cost 2*s*. or 3*s*. more in one case than another, from no other cause than having a short field instead of a long one, or from being dilatory, instead of smart, in working the implement at both ends of its journey.

Mr. Bulstrode found that he could not get the full benefit from his patent snatch-blocks on account of another hindrance—the delay

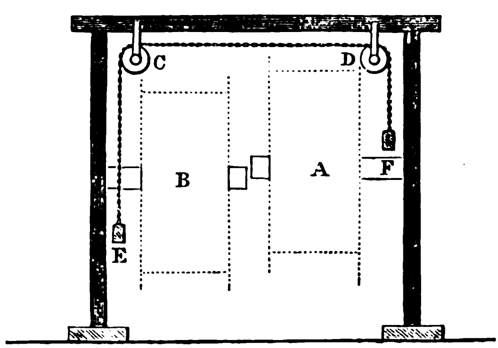


Fig. 1.

in reversing the two drums on the windlass. This he overcame

by a remarkably simple expedient. The windlass has two lever-handles for turning the eccentric "bushes" of the two rope-drums by which the raising "into gear" and lowering "out of gear" are effected; and Mr. Bulstrode wished to change the position of both drums simultaneously by a single movement instead of by first working one handle and then the other; so he set up a light wooden gallows over the two handles (see Fig. 1), or, as he expresses it, he "balanced the drums." Thus, the windlass-man drops the drum A in the act of lifting the drum B; a chain running over two pulleys C and D, connecting the two handles E and F. The labour also is easier.

After this, it was found that a few seconds might be gained at the implement; for time was wasted in taking the steerage-handle off one end of the cultivator and pinning it securely upon the other end. This point had been already attended to by Messrs. Howard, and was remedied by the use of a double-hinged handle instead of the single moveable handle.

One other *occasional* hindrance remained. When the steam was shut off, the recoil arising from the tension of the tight rope sometimes caused the pinion-shaft to run the reverse way for a few revolutions; and it was not safe to throw the drum into gear while this was taking place. To meet this, Mr. Bulstrode gave the engine-driver a wooden lever, which he presses as a brake between the fly-wheel and the fire-box the instant he has turned off the steam. Thus, by a few simple contrivances, almost all the advantage is got out of the patent slings, and the delay from shifting snatch-blocks is absolutely *nil*, though hindrance at each end of the field, from other causes, still amounts to 10 seconds.

Mr. Bulstrode's pulleys are mounted upon wooden boat-shaped sledges, instead of upon flat boards, in such a manner that, while combining the utmost strength and lightness, they ride over rough ground either to the right or the left, without loading themselves with earth.

One point is worthy of attention in his construction of pulleys or snatch-blocks.

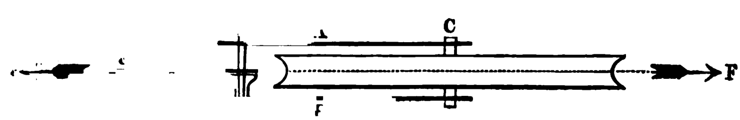


Fig. 2.

He always employs a bottom iron bar, B (see Fig. 2), as well as a top bar, A, because the wooden base-board is liable to decay and to fracture by accidents, and because he can thus *make the*

pulley "run true," even when the centre-pin, C, is much worn. For this object he always keeps a stock of pieces of gas-piping, of various lengths, shaped as in Fig. 3, which will slip over the upright pin, D (Fig. 2), selecting the size of the "stop" under the draft-iron, G, so that the draft-line, E F (between the arrows), Fig. 2, shall be exactly in a line with the middle of the rope pulley. Of course, the lower the sheave (or pulley) the shorter is the "stop" put on. If the draft-iron, G, be too low, the upper rim of the pulley will grind against the top bar, A; and if it be too high, the lower edge will do so against the bottom bar, B; and, in either case, the wear of the centre-pin, C, is increased and unequal, and the risk of overthrows and breakages greater. "This simple matter," says Mr. Bulstrode, "has saved pounds in snatch-blocks and in breakages."

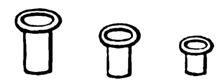


Fig. 3.

He does not use the Bedford "compensating" double snatch-blocks, but considers that the one thing still wanted is a compensating-brake, by which the power now lost in giving sufficient tension to the slack or tail rope could be added to the draft of the tight or pulling rope. He has designed one on an entirely different principle to the compensating-brake once brought out by Mr. Fowler, but has not yet got it sufficiently simple.

No. 103. Mr. E. W. Browne, of Langton, near Wragby, Lincolnshire, with Mr. W. Lacy, of Panton, and Mr. Christopher Robson, of Tupholme, are partners (the late Mr. Thomas Greetham, of Stainfield, was a fourth), in a "set" of two 14-horse Fowler engines. These cost 1496*l.*, and started in April, 1864. Mr. Browne's farm, of 430 acres arable and 163 grass, has a strong clay soil, with a blue clay subsoil, in fields averaging 30 acres in size; but the 2400 acres arable, embraced in the four farms, includes a variety of soils, from some of the strongest clay in Lincolnshire to light sand. This one apparatus does all the heavy tillage of these four large and medium-sized farms, and also a considerable quantity of work for other people. In the very first year, between April and winter, it cultivated or ploughed 1620 acres. Mr. Browne has reduced his horses from 16 to 12; the other partners have also reduced their teams, but we do not know whether in like proportion: if so, the steam-tackle will have displaced on the four farms no fewer than 18 horses.

The engines do 6 to 8 acres per day of ploughing, or 15 to 20 acres of cultivating (in long days more) per day, burning coals which cost 13*s.* a ton, at a railway station half-a-dozen miles off;

and the six hands employed (for the set is well manned) are paid 24*s.*, 20*s.*, 12*s.*, and 7*s.* each per week. When not cultivating, the men are employed on the several farms. We should add that the partners here have the advantage of first-class management, their machinery being under the care and energetic direction of Mr. J. Smith, of Alford-road, Louth, whom we shall presently refer to as a proprietor of apparatus working by contract.

The regulations governing the joint use of the engines appear to be these:—At harvest-time the first partner who gets a stubble clear of corn is entitled to the first turn; he is allowed to do 60 acres, which may be about three days' work, and then the engines are at liberty if wanted by another partner. The four farmers charge themselves 6*s.* per acre for cultivating and 9*s.* for ploughing or digging, finding coal and water during work and on the journey away. Two outlying farms, belonging to two of the partners, 4 or 5 miles away from the nearest of the four farms, and nearly 20 miles from the furthest of these farms, are charged at the full tariff of prices, just as in general work done on contract.

We have not learned the precise principle on which the fund raised from the four farms is apportioned for repairs, interest, and depreciation; but this point will be considered in the report of our next case of co-operative working.

No. 104. Mr. Richard Kay, of Forcett Valley Farm, near Stanwick, Darlington; Mr. Samuel Rowlandson, of Newton Morrell, Darlington; Mr. Luke Seymour, of Aldborough, Darlington; and Mr. Smurthwait, of Holme House, Darlington; all in the North Riding of Yorkshire, are partners in a "set" of Fowler's tackle, consisting of a 12-horse engine and anchorage, 4-furrow plough, and a 7-feet-wide cultivator, fitted with "points" of 4 to 10½ inches breadth. Ten farmers had agreed to unite in the purchase; but, upon consideration that too much time would be wasted in long journeys from one to another, and also that reduction of horses (one of the chief aims) would be in a great measure prevented when only a small share of work on each farm fell to the engine, the number of partners was reduced to four, occupying in the aggregate over 1200 acres arable and 500 grass. And there is no doubt that, while a special personal interest is taken in the well-being of the apparatus (each one of the four partners desiring to get the most he can out of it), this plan works far better than an association of many co-proprietors, among whom might be several who were inattentive to the details of their steam-operations. And we should say that, in general, two partners would be more likely to work steam-tackle

The "rules" of this partnership are pretty much as follow:—A capital of 1000*l.*, to be raised in four shares of 250*l.* each; no member to dispose of his share to any person not a shareholder without the consent of the shareholders, or having offered it to the company or to any member thereof. The committee of management to consist of all the members, three forming a quorum; any dispute to be settled and become finally binding by a majority of the whole. All fair wear and tear to be borne by the funds of the company. Breakages of working parts (not framework, or engine) to be borne, one-half by the user and the other half by the company. Any dispute to be settled by the committee. Share-points to be found by each user. Oil to be found by the company, and placed under charge of the engineer. As to order of use and priority of claim, one week's work is allowed to each member or to his tenant; the second *employé* is to fetch the apparatus from the first, the third from the second, and so on. If any intermediate members exchange turns, it must not prevent the tackle being used by the succeeding member in his due order. The first user to find coal and water for removal to the second, the second for the third, and so on. Four days of storm or stopping by breakage not to count as "use." Whichever member is ready first after harvest takes first turn, then the others in rotation, as settled when the partnership began. The engine-man, ploughman, and anchor-man are paid by the party they may be working for; and in a slack time each farmer employs the man living nearest to him, at ordinary farm wages—full-pay being made up by the company. Each user of the tackle has to find his own water-cart men, horse and porter-lads.

The whole machinery cost 885*l.* in February, 1862; and additions, repairs, &c., for the first 16 months, up to May, 1863, amounted to about 250*l.* more. Since that time two new ropes have been worn, costing 100*l.*; and the breakages have been costly, from landfast stones; by the substitution of steel for metal skifes, however, most of this loss has now been avoided. The repairs of engine and apparatus, petty repairs, renewal of rope, and cost of oil (that is, everything excepting coal, water, and labour), have amounted to these sums:—for the year 1863-4, 228*l.* 4*s.* 8½*d.*; for 1864-5, 106*l.* 7*s.* 2½*d.*; for 1865-6, 202*l.* 18*s.* 7*d.* But this latter includes a new fire-box, the old one having been fairly burned out. (A metal fire-box is considered to last only 4 or 5 years; whereas a copper fire-box would probably last 10 or 12 years.) So that the expense of repairs is really lessening each year; which is due, in great measure, to the fact of the big stones having been found by the first deep work, and now removed. The average outlay for repairs and renewals of parts has

been 179*l.* 3*s.* 6*d.* per year, but will be much less for the future. Excluding the first year, the number of days' work done on the four farms is as follows:—May, 1863, to May, 1864, 157 days; May, 1864, to May, 1865, 121½ days; May, 1865, to May, 1866, 112½ days; a total of 391 days; or an average of 130 days in a year. It will be observed that this is a gradual decrease of time, and, upon the last year, a saving of 25 per cent. from the second. The time lost by stoppages from accidents or bad weather has not been booked, the men going to farm-labour as soon as they cease working. Ordinary labourers here have houses, coals led for them, potatoes, &c., making, with their wages, about 18*s.* per week. The steam-hands are paid thus:—engine-men, 23*s.*; ploughmen, 18*s.* per week for the first year, 20*s.* for the second year; and the anchor-men, 16*s.* per week; the two porter-lads and water-leader, 9*s.* to 12*s.* each. No gratuities are allowed; and paying by the acre is objected to, seeing that the men would drive too fast, and this would not answer among so many land-fast stones. The leading of 350 to 400 gallons of water is done by one horse, the distance rarely exceeding 30 chains. The apparatus can be taken up and "re-set" in an adjoining field in two hours by help of 2 horses, but each man must know his business well to get it done in that time.

Coal, costing 7*s.* a ton at the pit, and with leading home, say 14*s.* per ton, is burned at the rate of 8 to 10 cwts. per day, say 6*s.* 6*d.* worth per day. The annual expenditure may be summed up thus:—

	£.	*s.*	*d.*
Labour, 130 days × 14*s.* 8*d.*	30	6	8
Water-cart horse, 130 days × 2*s.* 6*d.*	16	5	0
Removal-horses, 130 days × 6*d.*	3	5	0
Coal, 130 days × 6*s.* 6*d.*	42	5	0
Repairs, renewals, rope, oil, &c., 130 days × 27*s.* 6¼*d.*	179	3	6
Interest, 1000*l.*, at 5 per cent.	50	0	0
Depreciation, say 800*l.*, at 5 per cent.	40	0	0
Total, 130 days, at 55*s.* 6¾*d.*	361	5	2

The engine is occasionally used for thrashing; but no allowance is made for this in the above statement. Mr. Rowlandson, who has carefully kept all the accounts, and who has large experience of mining machinery, agrees with us that, after full repairs are charged, 10 per cent. would be an excessive allowance for "depreciation."

The immediate return from a yearly outlay of 361*l.* 5*s.* appears in the saving of 12 to 15 horses on the four farms,—though one of the four partners has not yet reduced his team-force at all. The sum saved is thus 528*l.* to 660*l.* per annum; and deducting

361*l.*, the total cost attending the steam-machinery which has taken the place of the banished horses, we see that a balance of annual profit of 167*l.* to 299*l.* has accrued to the partners.

This being the case, to say nothing of improved cultivation and augmented produce (which will be referred to presently), it does not much matter whether any single operation may have cost more or less than ordinary horse tillage costs per acre: particularly as this set of tackle declines all contract-work, because of the stones not yet cleared out of the land that might ask to be steam-tilled. However, the daily performance and cost per acre have been as follow:—On Mr. Rowlandson's farm of very strong loam, with variable subsoil, very full of landfast stones, the average ploughed or dug has only been 3 up to 7 acres a day, depending upon the length of the fields and the state of the weather; 40 acres were dug 9 inches deep, and the tackle shifted in 10 days; or 4 acres per day. At 55*s.* 7*d.* per day, Mr. Rowlandson's deep-ploughing and digging thus cost 8*s.* to 13*s.* 11*d.*, or even sometimes 18*s.* 6*d.* an acre. Mr. Kay's deep-ploughing and digging on gravelly loam, with variable subsoil, full of earthfast boulders, is done at the average rate of 4 up to 8 acres per day; that is, at 6*s.* 11*d.* to 13*s.* 11*d.* per acre. On both farms the cultivator does, 10 or 12 inches deep, 10 to 16 acres a day, at a cost of 3*s.* 5*d.* to 5*s.* 6½*d.* per acre.

The total acreage done in a year, that is, in 130 days, upon the four farms, includes about 200 acres of digging for fallow, 100 acres of turnip-land ploughed for barley, 50 acres of clover ploughed for oats or wheat, and 150 to 200 acres cultivated three times over for turnips; making 450 to 600 acres of cultivating: in all about 800 to 950 acres in the year. This is at the general average of 6 to 7½ acres of deep work per day. In deep fallowing the average is about 4 acres per day. Just before the time of our visit, Mr. Rowlandson had dug, 9 inches deep, 16 acres of stubble in two days, in a large field which had been moved by steam last year; and as this was really "5-horse work" per furrow, the digger took as many furrows at once as 20 horses could have done, only so much faster, and so much longer at it in a day, that it effected as much work as 40 horses. However, next day only 2 acres were done, because of a stoppage; a stone threw one of the slack-gear drum-shafts out of truth, and then the pitch-chain slipped off. This accident frequently happens, apparently suggesting that these small drums should have flanges. Two years ago the engine ploughed, 5 inches deep, 30 acres in four days, including a removal into another field.

We found Mr. Kay's farm close by the Duchess of Northumberland's Hall at Stanwick; but, owing to the pouring down-

fall of the day (November 16th), we could see nothing of the land, and could sympathize with the occupier, whose energetic management was so confronted by the season that his barley and oats were still uncut. As 12 miles of fences have been stubbed on 360 acres arable, his fields now range from 10 to 50 acres, and his boundaries are straightened; this work of improvement having added 9 acres to the available tillage-area of the farm. The soil is loamy, on a drift formation, with great numbers of boulders, which have to be taken out, while fresh ones are continually found. The land is most of it strong pair-horse ploughing. The farm is under-drained, and drains well; and flat-ploughing was the custom of the country before steam came. The steam-engine smashes up stubbles, and cross-cultivates in spring; and in general it does all the heavy work of the four farms; being here made "the slave," and not the "auxiliary." The steam-plough is used only to turn over the clover-lea 6 inches deep for oats, and to do the last tillage just before sowing turnips. The work, Mr. Kay says, is forwarder; but he does not obtain either a smaller labour-bill, or any particular increase in cropping. It should be stated, in connexion with this last fact, that Mr. Kay had practised 10-inch deep ploughing by four horses to a plough long before steam came, and the land being always adapted to turnips, he could make no increase in the breadth of roots.

He formerly employed 13 horses in winter, and 15 in summer, the additional summer horses running off in straw yards, at little cost, in the winter,—he now uses 8 in winter, and 13 in summer; but, if he had only one partner in the steam tackle, he could make 10 horses do in summer. With single-horse carts, this team-force is quite sufficient for despatching all his harvest carriage, and working two reaping-machines as well. Moreover, the very powerful horses formerly required, are now either replaced by lighter ones, or, at least, kept at less cost.

We called upon Mr. Seymour, one of the partners in the steam-tackle. His testimony was that he could plough more cheaply by horses, and that steam had not improved his crops a bit. But he confessed that his land was entirely unsuited for steam cultivation; and that rock and innumerable stones had proved a sore trial to the machine: still he had become a partner for the sake of aiding the introduction into the neighbourhood of that might benefit farmers of land in a more kindly situation.

Mr. Rowlandson's 300 acres arable consist of a strong loam, taking 4 and even 5 or 6 horses to plough 8 or 9 inches deep; the surface generally level, and in fields of 8 up to 40 acres each—many old fences having been taken out, and, in some cases, new ones planted. As an illustration of the trouble and expense incurred from the stones—the enemies of steam cultiva-

tion—he told us that 100 tons of boulders had been taken out of a 42-acre field: A large portion of these are granite, some weighing as much as 4 tons apiece, a stone of that size extending from the surface to a depth of 3 or 4 feet. Some are removed by being dug round; but 14 or 15, in that 42-acre field, had to be blasted by gunpowder in mining fashion.

As to results of steam culture, he thinks that the drainage is much assisted from the complete breaking up of the solid "pan," and he thinks that the land bears treading with sheep in winter better than it used to do.

He formerly sowed 40 acres of turnips, now 65 to 75 acres; but, by breaking up the clover in July by steam, he has sometimes obtained 100 acres of turnips. Sometimes he has thus worked the clover-lea early and well in preparation for wheat. While he finds a very great improvement in the whole of his strong-land cultivation, he gets better corn after the turnips than he used to do after bare fallow; and thinks that the wheat stands better upon clover-lea broken up in July and August—it used to go down and blacken with mildew. "The wheat crops especially," he writes, "have been more productive," which he attributes to the thorough working of the land in summer and autumn; but, at present, it is too soon to estimate the percentage of increase in the yield.

He used to keep 13 to 15 horses in summer, and yet this last summer worked only 12: in winter he used to have 12 or 13; this winter he has only 8.

Steam culture has to contend in the North Riding with the impediment of small occupations of 100 to 200 acres: 40, 50, and up to 100 acre holdings are very common; and 400 acres make quite a large farm. And Mr. Rowlandson thinks that steam tackle should not be possessed by a farmer of less than 500 acres of strong land, or 600 acres of medium land. But we need not repeat that various examples of successful steam culture upon smaller quantities of arable appear in this Report. The fields are so small and irregular, that the hiring system would be at great disadvantage; in fact, preparation of the farms for steam tillage is urgently wanted. This is a landlord's question: and we cannot help asking, Why is it that removal of hedge-rows is delayed, when Mr. Kay's 12 miles of stubbing actually gave his landlord 9 acres more ground?

We heard here an unexpected objection to the double-engine system: the independent temper of the workmen, it is thought, would not let two engine-drivers agree, and there is already trouble enough to secure one good man.

Particulars of Farms in the Section "Partnership":—

Reference No. of the Farm.	Acres Arable.	Nature of Soil.	Apparatus.	Horse-power of Engine.	Acres Ploughed per Day.	Total Cost per Acre.	Acres Cultivated per Day.	Total Cost per Acre.	Total Yearly Cost of Steam Tillage.	Reduction in Number of Horses.	Number of Horses now kept to each 100 Acres.
Two Farms 98 99	500 750	Stonebrash	Fowler's Eddington windlass.	10	..	..	9 to 12	6*s*. 6*d*. to 8*s*. 6*d*.	? £200	19 to 13 20 oxen saved	2¾ ..
Two Farms 100, 101	700	Clay	Smith	8	..	..	..	..	..	29 horses and 12 oxen to 23 horses.	3¼
Two Farms 102	About 600	Loam, gravel and clay	Howard	10	..	..	9	7*s*. 5*d*.	£151	8 horses saved	2⅔
Four Farms 103	2400	Clay and loam	Fowler	Two 14	6 to 8	..	15 to 20	..	..	18 horses saved	..
Four Farms 104	1200	Loam, and strong land, very stony	Fowler	12	3 to 8	7*s*. to 18*s*. 6*d*.	10 to 16	3*s*. 6*d*. to 5*s*. 6*d*.	£361	12 to 15 horses saved.	..

SECTION IV.—THE HIRING SYSTEM.

Division 1.—*Private Ownership.*

No. 105. To see a contract "set" in actual work, we visited Mr. William Torr, of Aylesby, Grimsby, Lincolnshire: and, as may be expected, could not forbear stealing for a short space from our duty, to look at old "Breastplate," young "Royal Bridegroom," the splendid roan "Riby Queen," and lots of Booth calves, in one of the largest and grandest herds in existence; besides some remarkably fine Leicester tups, possessing size as well as quality, "the climate growing them big." But shorthorns are not an exclusive hobby at Aylesby; everything in field management or farmstead arrangement is well done, of course, including special preparations for steam-power husbandry.

Mr. Torr has filled up open ditches, laid pipes instead, and conducted these mains into corner tanks, where two or three fields meet. Each tank, of brick and cement, is $3\frac{1}{2}$ by $2\frac{1}{4}$ feet wide, and deep enough to receive the discharge of a 4-feet deep drainage, the cost being about 6*s.* or 7*s.* each, a man being able to set two in a day. The tanks are valuable for showing if the drains run (and they have shown that the drains begin to act much quicker after steam than after horse culture), and for supplying water when the 9-inch outlet is temporarily stopped up for the purpose. A pump set in a cart is taken to any one of the tanks; and for carrying the water, two common carts are employed, with a barrel upon a tressel foot in each.

We found a couple of 14-horse Fowler engines at work upon a field of strong loam, which may be called "pair-horse" land, because Mr. Torr employs two horses in a plough; but then his are teams "well greased for going." In reality, this is fair "3-horse land." The balance cultivator was doing tremendous work, heaving up huge slags, shattering and tossing them in all forms, at a depth of 9 to 11 inches, the implement travelling at a high speed, and labouring over hills and hollows like a ship at sea. The rate of performance was 18 acres per day; and Mr. Torr paid only 10*s.* an acre for over a hundred acres grubbed 11 inches deep last spring. Two boys were working 6 rope-porters, and we observed that, on an average, only 15 seconds of time were lost at each end. The extraordinary handiness of the double-engine system was exemplified in the act of changing the cultivator for the digger. One engine advanced a little on the headland, so as to haul the cultivator upon the broken ground out of the way of the next implement; it then backed along the headland to fetch the digger, and returned to its original position. The rope from the other engine was now too short to reach the digger, so the first engine rope was pulled out a few yards by

hand, and hooked to the far-engine rope, which was then pulled up by the first engine till it reached the digger. The work wanted squaring off, and by a succession of gradually shortening bouts, this "gore" was worked off to perfection.

Mr. Torr has not yet materially reduced his number of horses; but nevertheless expresses his great satisfaction with the hired assistance, that enables him to get on more quickly with his work at the best season, to accomplish "hard jobs" with ease, and execute a style of tillage with which no horse-work can be compared.

This set of tackle belongs to Mr. J. Smith, of Louth, and has been working since 1863, while another set (in the same hands) had begun in 1862. These are "14-horse engines" upon "12-horse boilers." Three men and two boys work the apparatus, but an extra hand is also employed to "relieve all through," so that the engines never stop all day. They are good, well-trained hands; and no little nerve is required for driving so sharply and closely as they do hour after hour without accident. It is all day-work, seeing that piece-work would be too powerful a temptation to "scamping" the depth of tillage. The engineman and ploughman have 20*s.* a week each, the porter lads 12*s.* a week each, for 10 hours a day. But they make overtime, reckoning even to half an hour; and in spring and autumn they have sometimes worked the extreme hours of from 3 o'clock in the morning till 10 o'clock at night. For a few days, up to a week of stoppage by bad weather, or other cause, they are paid full wages, as in this short time they are sure to be cleaning out boilers, "putting on a washer, or something." There is, however, a "slack time." The engines generally make a start in March, February weather being very uncertain, and keep going till the middle of June. Then comes a slack time, until the last week in July, when work begins again, and holds right away to Christmas. During the slack month in June and July the men are allowed 1*s.* each, and the boys 9*d.* each per day; in addition to which they get plenty of work upon farms. At the Christmas stoppage the wages stop too, until a fresh agreement is made with the hands for the next start in February or March. And during this winter vacation, farm employment is found even more readily than in summer, such as draining strong land, marling on the Wolds, thrashing, and so on.

Ordinary small repairs are done by blacksmiths, wherever the engines may happen to be; all important parts are obtained direct from Leeds. The employers find coal and water, coal at 16*s.* a ton, at home, being burned at the rate of 1½ up to 5 cwts. per acre, according to the nature of the work; and the bargain is that the farmers shall fill up the "tanks" or "tenders" with

coal and water before the engines leave, a tank full of water lasting four miles on the road. Mr. Smith began contract work as low as 8*s.* per acre, finding his own coal, but soon experienced the folly of having made too low an estimate of his expenses. He now charges 9*s.* up to 16*s.* an acre,—say an average of about 10*s.* 6*d.* an acre, for different sorts of work, the farmer finding coal and water. To avoid loss, it is necessary to "charge enough" for "bad pieces."

Engagements are made beforehand with several occupiers in succession, and punctuality is studied, so that rather than disappoint a customer who may be unwilling to wait beyond the appointed day, Mr. Smith leaves a field half done. If a number of farmers were to combine, offering a certain total area, and so much land each, then he could engage to do only a stated quantity at once for any one man. And in that case, farm-horses might be sold off, because the farmer would be sure of being able to hire the apparatus. At present, the saving of horseflesh is confined to lighter work and cheaper maintenance, the uncertainty about getting any steam work forbidding an actual selling off of teams. And this is simply for want of an arrangement that might be easily entered into between half a score of farmers and the contractor. (*See* "The North Lincolnshire Company" in *Division* 2.)

Most of the tillage has been upon fair 3-horse land, and more than half of it in a heavy clay district. The 14-horse "set" has cultivated three acres per hour as an unusual feat, 2½ acres per hour with the "drag" being good work. Excessively long days are run in some seasons; and once, in cultivating a light soil, the engines executed within an acre of 70 acres in three fields setting down and taking up tackle six times in three days.

Mr. Smith expresses himself satisfied with his business; his employers do more and more work with the tackle every year; and, with good management, he considers that contract working will pay, even on light land. In fact, on the Wolds, where a couple of horses can plough 1½ acre per day, he has done steam cultivating 5 inches deep, that was profitable. But then, Mr. Smith, formerly one of Messrs. Fowler's managers of show tackle, is reputed as one of the cleverest and most energetic machinemen in the country; and, as he himself said to us, making the business pay is "just a question of management." The very simplest details have to be watchfully superintended, and time most jealously husbanded. Each field has to be previously inspected, and the operations laid out according to its circumstances. Thus, if there is a hill, the rule is to begin across the bottom, for ploughing, turning the furrows downward; but for cultivating begin across the top of the field, because of easier turnings at the ends.

Moreover, if, on a steep hill side, a wheel of the cultivator happens to get into the cultivated ground, it cannot be got out again into its proper track on the unbroken ground, if the work is begun across the bottom, instead of the top. Again, when a level field is to be "done and crossed" (if no other more important consideration chance to interfere) always begin the short way first; this making the shortest journey of the engines over worked ground, when changing from one operation to the other and when leaving the field. But should the gateway happen to stand "midside" instead of at one corner, this rule must be violated.

Where, of necessity, the distance between one job and another consumes much more time than is lost by the farmer employing his own apparatus, it is only by judicious planning and incessant personal attention that sources of loss can be avoided; and it is owing to Mr. Smith's care and forethought that he is able to report, "we have only been stuck fast once, and that was in an old filled-up 'stell' in the marshes." *

No. 106. We have the opinion of another first-rate manager and proprietor of contract apparatus, Mr. Henry Yates, of Abbey-street, Derby, that "3-horse land" pays the letting man best: clay, without stone in it "pulls dead,"—indeed, the engines find very great and unexpected differences in the mechanical "tillage value" of soils, which horse teams merely pull through all the same. Until some new implements are brought out, the contract man cannot compete against 7*s.* or 8*s.* an acre horse-ploughing, though he can do the work wonderfully quicker and better: cultivating is the deepest, best, and most expeditious of steam work. The wear and tear being so much greater than in the case of tackle limited to a farm, the only chance for the letting-man is that the farmer shall be willing to pay for the *accommodation* of having his work done when most required: and certainly, the fact that horses would plough or cultivate at so many shillings per acre ought to be no test of what a job may be worth, when the farmer has no horses to spare for the operation just when it ought to be done. Unless handsome prices are earned during the autumn (when any "set" can always have more work than it can do) a man cannot stand against the slack season of May, June, and July; except, indeed, he is lucky enough to be in a dead-fallow district, where a portion of summer tillage can be found for his engines. Thus, Mr. Yates has worked two "double" sets of Fowler's 10-horse tackle, for eighteen months together, every day when the weather was suitable.

Employers of hired apparatus need to be reminded that the

* Mr. Smith remarks that no engine ought to travel on the roads after dark, either with lights or without.

cost incurred by the steam-contractor in doing the work is a point with which they have really nothing whatever to do; the main question for them is, what is the value of the tillage when done? And they must consider the various elements of value in the work: it is worth so much more than horse-work on account of its greater depth, its freedom from trampling, its more effectual shattering and disintegration of the soil. It is also worth more, because of its celerity of execution, quite irrespective of its mechanical excellence: you willingly pay more per mile to travel by an "express" than by a "Gov." train, because time is an object with you; and on the same principle, when saving of time, catching opportunities of fine weather, and general forwarding of operations, are all-important toward obtaining more even and better crops, an acre ploughed in one hour is worth far more to you than an acre ploughed in two hours. And to those who may find any difficulty in thus appreciating expedition in tillage, we commend Mr. Bomford's use of two double-engine sets (*see* No. 69), and again, the estimate offered in Mr. Randell's case (No. 67), where the steam culture costing him 14*s*. an acre is shown to be in effect worth 23*s*. an acre, from the saving of yearly expenses without taking into account any further advantages that he may reap in his augmented cropping. And his is by no means the only, perhaps not the most striking example of the gain by "promptitude and dispatch," which the old copy-book declares, "are the life and soul of business."

No. 107. Mr. William Bellhouse, of Escrick, York, has let out a set of Fowler's "10-horse" double-engine tackle since May, 1864. The prime cost, with 4-furrow plough, 7-tined cultivator, water-cart, and extras, was 1300*l*. An exchange of engines in June, 1865, cost 100*l*.; a harrow, since purchased, 50*l*.; and other additions, steel skifes, lamps, &c., about 20*l*.; making the whole investment, 1470*l*. The breakages and ordinary repairs have amounted to about 125*l*., and new ropes in February, 1865, 84*l*., altogether 209*l*. The engines consume 16 to 20 cwts. of coal per day; oil costs about 2*s*. 6*d*. per day,—for "some men will use twice as much as others." Only three men work the tackle; rope-porters being considered no saving when the land is level and free from gravel. The wages are 14*s*. a week for each man all the year round, with 1*s*. 6*d*. per day extra when working the apparatus. During slack time the men are at liberty to pick up employment wherever they can.

The fields worked upon a large number of farms vary from 7 up to 40 acres each, the average size about 12 or 14 acres. Little ploughing has been done; of digging, the greatest quantity per day has been about 8 acres, the average about 5 acres, almost

always on clay land. Of cultivating, the greatest quantity done on light land has been 16 acres a day, but generally on strong heavy soil, the average is 1 acre or less per hour.

A removal is accomplished to an adjoining field in 15 or 20 minutes. Three men move the whole, without assistance from horses, except that occasionally it is convenient to pull the rope across the field with a horse at starting. On the road "six men are required according to the new Act."

The rates charged per acre are, for—

Digging	16*s.* to 20*s.* in strong land.
Cultivating	7*s.* to 14*s.*, according to soil and condition.
Harrowing	About 5*s.* per acre, twice over.

Mr. Bellhouse says, "During the first year, after I fully got to work, the tackle worked 200 days: under favourable circumstances, I look for 150 or 160 days' work in a year; but have come to the conclusion that, generally speaking, it is not advisable to attempt steam cultivation between the middle of November and the middle of the next March. Since I exchanged my engines, the most serious breakages have arisen from inattention or inexperience on the part of the men."

As an example of the hazard attending contract steam-ploughing in some localities, we may mention that, a "set" had to quit the Holderness district of the East Riding, because of the "brack" water depositing salt in the boilers. These had to be cleaned out every day, a few pounds of salt being liable to damage them irretrievably.

No. 108. Mr. C. Hill, of Dogsthorpe, Peterborough, Northamptonshire has managed one of Fowler's double-engine sets for three years, performing only contract work. The Committee did not see Mr. Hill, as he was at the time of our call working his apparatus, a dozen miles away; but we learned that he has work enough for this pair of 12-horse engines, excepting for about three summer months in autumn, and could employ two or three sets of engines if he had them. There is no difficulty in finding work for the men during the vacation in the ploughing: they get employment upon different farms because labour is in great demand just at the season when the engines set them at liberty. But in the first year Mr. Hill allowed one shilling a day to each man when not engaged with the apparatus; a tax for which there is now no necessity whatever.

No. 109. The Earl of Ducie has three tenants on his property near Chipping Norton, who work steam-ploughs of their own; but he keeps a "set" for the use of any other tenants on the Sarsden estate. The following particulars are given by Mr. Henry Andrews, the agent, in his replies to the Society's schedule of

queries:—The apparatus is a Fowler 14-horse engine, with 4-furrow plough and 7-tined cultivator, bought in 1863 for rather more than 900*l.* It is worked upon level and hilly ground, in fields generally of 10 to 20 acres in area, some much larger, small fields having been united so as to make the inclosures of convenient size; and the "access" to fields has been altered in some cases. The soils it has to work are those of the oolite and Oxford clay formations, of which it ploughs or digs 6 acres a day, or cultivates 8 acres a day. The coal consumed is 12 cwts. a-day, at 9*d.* per cwt., with a shilling's worth of oil. The water is obtained from wells and streams, and drawn in a water-barrel by one horse, at a cost of 4*s.* a day. A removal takes 7 horses and 7 men and boys, one hour to take up and another hour to set down. The hands are two men at 2*s.* each, one youth at 1*s.* 6*d.*, another youth at 1*s.* 4*d.*, and a couple of boys at 1*s.* each per day. These low wages for men working machinery are paid throughout the year; and, when not engaged in cultivating, the steam-hands are employed in the woods and plantations—in draining, ditching, and general improvements on the estate. "The repairs," Mr. Andrews says, "may be taken at 5 per cent.; some years considerably less, in others more." Delays from breakage have been a day or two at a time, sometimes even a week. The apparatus has been used 3¼ years, in which time "2000 acres, 3 roods, 34 perches," have been ploughed, dug, grubbed, or scarified; whereas 4000 acres could have been done, as the engine is not employed for thrashing, sawing, or any work beside land-tillage. If the tenantry were to fully avail themselves of this apparatus, they might dispense with a great many horses.

Mr. Andrews says that the drainage of strong land has been rendered more effectual by the use of "steam;" the acreage and particularly the weight per acre of root-crops have been increased, "the young plant in dry weather being much more certain than when prepared for by the ordinary method. The crops generally have evidently increased under steam cultivation: how much is to be attributed to this, or how much to the generally-improved method of farming, I am not prepared to say; it is certain that both have contributed in producing the result. I think, however, that steam has the advantage of the two."

The prices charged for work are no criterion whatever for the guidance of letters and hirers of steam-tackle; they are purposely low, for the sake of getting steam-work patronised by the tenantry for their especial benefit. We believe that "the estate-engine" grubs at 6*s.* per acre, and 6*d.* per acre less for all over 100 acres. This "encouragement" of steam tillage at a sacrifice (for such prices will probably never pay for repairs, &c., of a travelling apparatus) was offered to carry out the exceedingly liberal views

of the late Mr. Langston; but it cannot be sound policy in the long run, and we suppose must put at a discount the letting-out "sets" owned by some of the tenantry and by other business-men in the locality.*

No. 110. Mr. Thomas Colsey, agent to Lord Sudeley, lets out a Howard set of tackle (with one engine). In 1864 the

Total number of days working was	98½
Days lost by bad weather	14
Days lost by breakage, about	24

And 40 days more were lost through lateness of season in commencing.

When not steaming the hands are employed in general estate-work, such as repairing roads.

As an index for hirers and proprietors of apparatus, we give the following "card" of prices charged:—

TODDINGTON STEAM PLOUGHING AND CULTIVATING APPARATUS.

The following Terms are to be taken only as a basis for the Charges of Hiring the Steam Apparatus.

PLOUGHING.

		£.	s.	d.
Stubble, 6 inches deep	per acre	1	0	0
After green crop, ditto	"	0	17	6
Stubble, 8 inches deep	"	1	5	0
After green crop, ditto	"	1	1	0
Stubble, 9 inches deep	"	1	10	0
After green crop, ditto	"	1	5	0

CULTIVATING.

Breaking-up Stubble, Seeds, &c.

		s.	d.	£.	s.	d.
Six inches deep, once over	per acre	12	0	0	19	0
2nd time over	"	7	0			
Seven inches deep, once over	"	13	0	1	0	6
2nd time over	"	7	6			
Eight inches deep, once over	"	14	6	1	3	0
2nd time over	"	8	6			
Nine inches deep, once over	"	16	0	1	6	6
2nd time over	"	10	6			
Ten inches deep, once over	"	17	6	1	9	0
2nd time over	"	11	6			

Breaking-up old pasture (*in addition to the above charges*), once over, 3*s.*; second time, 1*s.* 6*d.*

Crossing Steam-ploughed Fallows.

		s.	d.	£.	s.	d.
Eight inches deep, once over	per acre	11	0	0	17	6
2nd time over	"	6	6			
Nine inches deep, once over	"	12	0	0	19	6
2nd time over	"	7	6			

* It was Mr. Langston's wish that his estate should exhibit a large breadth of steam cultivation, with varied results on soil, crops, &c., as a guide to other agriculturists—an incentive, or possibly a warning—and this without risk of loss to his tenants.—A.

Subsoiling below Plough-furrow.

		s.	d.	£.	s.	d.
Four inches below furrow, once over..	per acre	15	0	1	3	6
2nd time over	„	8	6			

The above prices will be charged for the working of ordinary clay lands; they will vary with the condition and description of the soil, the amount of work required to be done, the size and shape of the fields, the convenience of coal and water supply, and other minor considerations.

No field will be charged for as being less than 8 acres.

All expenses are included in the price named.

In consequence of the new engine being a *traction* engine the prices have been raised, but they include, *in addition to* the former charges, the expenses of removing the apparatus, for which purpose horses will *no longer* be required to be sent.

April, 1865.

Messrs. Howard's traction engine has the boiler placed transversely across a carriage-frame, so as to avoid fluctuations of the water-level in ascending or descending inclines; and the steerage is accomplished by a single wheel turning on a "transom" in front. It is fitted with two rope-drums, so that there is no separate windlass to be moved, set down, and so on; and the consequent celerity with which the apparatus takes up its position for work effects a wonderful saving in time.

Division 2.—Companies.

No. 111. The Herefordshire Steam-cultivating Company Limited (manager, Mr. John Phillips-Smith, of Hereford), which works two sets of Howard double-engine tackle, two cultivators, one 4-furrow plough, one set of steam-harrows, and four mole draining-ploughs; and the North Lincolnshire Steam-cultivating Company (manager, Mr. Richard Toepffer, of Kirton-in-Lindsey, Lincolnshire), and some other contract steam-tillage "concerns" we have not been able to visit.

Concerning the operations of the Lincolnshire Company, Mr. Toepffer has obliged us with the following answers to inquiries:— "We have three sets of Fowler 'double-engine' 14-horse tackle. We can work, on an average, from the 1st of April until the 31st of October, that is seven months, in which period we calculate having about 120 full working days. During the five months from 1st November to 31st March all the hands are employed in our mill, manufacturing oilcake and compound corncake. We can *find* work in March, and almost all the winter through. Our work is very often of the very worst fields of the farms: but we have many customers who contract with us, for instance, in spring, for crossing most of their turnip-land; in summer, to cultivate most of their summer-fallows; and in autumn, to cultivate most of the stubble-fields. In several cases farmers have reduced their number of horses; in other

instances they have abstained from purchasing fresh horses, which, without the help of our steam-cultivators, they would have been compelled to do. We use, almost exclusively, the cultivator, because farmers like it best. We have also used the plough this year, but only to plough on the Wolds, turning over large seed-fields, 5 inches deep, for wheat—farmers, in these instances, being behindhand with their work.

"Our plan is to arrange beforehand, in general terms, with a number of gentlemen in one vicinity, to do a certain amount of work in a season, and mostly finish off the work on one farm before going to another. Most of our work is on light land, on the Wolds and Cliff, in 20 to 50-acre fields. Our charges for cultivating vary from 7*s.* to 15*s.* per acre—the farmer supplying coals and water. Strong land is often worked twice over, and in large fields averages 10*s.* per acre for each operation.

"The system of hiring steam-ploughs on the double-engine principle is the only one that is adapted to bring steam cultivation within the reach of small farmers. Where three, four, or more small occupiers in one locality agree to hire an apparatus, they can obtain it at the same cost as the larger farmers.

"All our customers tell us that, as long as they can hire steam-cultivators at a reasonable charge, they will not buy tackle themselves."

No. 112. The Herefordshire Steam Cultivating, Thrashing, and General Implement Company (Limited), Capital 5000*l.*, in 1000 Shares, began operations with the first pair of Howard's engines in 1865, and a second pair in October, 1865: at the end of that year the Directors declared a 5 per cent. dividend, and laid by a surplus of 91*l.* toward a Reserve Fund. The Report for 1866 is not yet published, but the manager informs us that they have made a larger profit than they realised the first year. They work the plough but little, the principal operations having been done by the cultivator, whether on loam and gravel soils, on sandstone shale, or stiff clay and marl, on lands where they have torn up immense quantities of rock fragments, or on deeper soils where the tillage has been 15 inches deep. The basis of the scale of prices is 1*s.* per inch depth. The engines have given every satisfaction, in a desperately hilly country, and cost very little in repairs. Mr. Philip Smith has applied his engineering ability to carrying out some novel operations. Thus, a mole-plough is hauled by each engine, draining meadow-land 2 feet deep, at 4-yard intervals, the mole-plough being of 4½ inches diameter. The cost to the farmer is 1*l.* per acre: by previously ploughing a deep furrow, a correspondingly deep drainage is executed; and the work is declared to answer exceedingly well. The advantage of this draining to the Company is that it provides

"wet-weather" work for the apparatus and men,—hitherto a weak place in "the hiring system." Mr. Smith has also begun to subsoil hop-yards between the rows of polls,—a single tine on the cultivator going 2 feet deep with a share at bottom of 18 inches breadth.

No. 113. On Wednesday, November 14th, we met by appointment in Wakefield ten gentlemen connected with "The West Riding Steam Ploughing, Cultivating and Thrashing Company, Limited," that is, nine directors and Mr. Charles Clay, the secretary; and, cordially appreciating the importance of our undertaking, they responded with the utmost liberality of feeling to all our inquiries, and freely submitted their books to our scrutiny. The accounts are kept in the most exact and business-like style, properly audited, and we saw the banking-account, stating the amount of the "reserve fund."

This, the earliest Company of the kind in the field, started and was "incorporated" in 1862, and its "Memorandum of Association and Articles," consisting of 93 articles agreed to, form a model to be studied by persons wishing to form similar Companies.

The capital is 3300*l.*, in 1*l.* shares, subscribed by 86 shareholders, and all "paid up" as far as shares have been issued. The first "set" that started in work was a double-engine 12-horse Fowler apparatus, with winding-drums, while another "set" of double 14-horse engines began in September, 1864. And the position of the finances may be stated in a few words, as follows:—The gross earnings are about 900*l.* a year, of which about 200*l.* a year is for thrashing. The total payments, exclusive of great repairs and replacements, are about 600*l.* a year; leaving a surplus of 300*l.* At the half-yearly meeting of the directors, held on August 2, 1866, a dividend of 5 per cent. was declared, say 150*l.*; thus leaving 150*l.* more for the "reserve fund." In three years (besides paying the dividends) 350*l.* have been paid into this fund, and the banking-book, at the date of our visit, showed a floating balance of 120*l.*

A modest dividend, of course, is preferable to mere solvency; but on learning the history of the Company's transactions, under a pressure of unfavourable circumstances, we admitted that the fact of a dividend at all having been realised clearly proved the profitable nature of the undertaking itself. The machinery has had nearly every difficulty to contend with. Its employers have been, for the most part, small farmers; it has worked for many men occupying under 100 acres each, even on 30 or 40-acre occupations. The inclosures are miserably small for steam cultivation, those worked in having averaged only 10 acres apiece; and though the engines profess to undertake nothing "under 8 acres," they have ploughed 6 and even 4-acre fields,

charging each as 8 acres. The fences, too, are crooked, and the shape of the fields often extremely awkward. Then, in travelling, they experience the difficulties of very narrow and bad roads; and though coals are certainly cheap so near to the mines, labour is correspondingly dear. But worse than physical impediments have been the restrictions imposed by law. Owing to difficulties with the magistrates about the locomotion of the engines by daylight, one of the two "sets" had to be shut up altogether from December, 1864, to July, 1865. Into the full losses of the Company from this cause, including the after-disadvantage of farmers losing confidence in the Company, (the element of uncertainty as to whether the tackle was procurable or not, leading men to make other arrangements for effecting their tillage,) we cannot now enter. It is enough to say that, the Act of Parliament passed for two years, permitting day-travelling (the only safe time), though imposing burdensome conditions upon the proprietors of engines, will expire in September, and must be renewed if Steam-Ploughing Companies are to continue in existence, or, in other words, if small farms are to obtain the benefits of steam cultivation. With "amendments," too; for if the "smoke-consuming" clauses of the present Act were to be put in force, the whole "hiring-system" would be at once done for.

As an illustration of the excessive number of journeys and changes which these engines have been obliged to make in this part of Yorkshire, we may state that in 1864 they worked for 38 different farmers, going to many of these several times over; and in 1865 they worked for 34 farmers. What was the work done? In the first half of 1865 (only one "set" able to be at work) the Company tilled 261½ acres, and thrashed 1302 quarters of corn; and in the latter half of that year (both "sets" in operation) they tilled 792 acres, and threshed 788½ quarters of corn. That is, 1053½ acres of tillage, and 2090½ quarters of thrashing were done for 34 farmers, and to do this, in many cases, the same farm was left and again revisited several times. In the first half of 1864 one "set" tilled 528½ acres, and thrashed 1523 quarters; and in the latter half of that year (the second "set" starting in September) 887¾ acres were tilled, and 1886 quarters thrashed. Thus, 1416¼ acres and 3409 quarters of thrashing were done for 38 occupiers. The engines travelled 318 miles in getting to and from the field-work, or averaged only about 4½ acres for each mile of road-work. And for the thrashing, the engines travelled no less a distance than 349 miles, getting less than 10 quarters of thrashing for each mile of journeying. As little as 10 quarters has been thrashed for one man.

In the first half of 1863, the first set of tackle did 680 acres of tillage, and travelled 61 miles to do 686 quarters of thrashing. In the second half of 1863, that "set" did 638½ acres of tillage, and travelled 182½ miles, its average performance being 6 to 8 acres of ploughing or digging, and 14 acres of cultivating per day. The work has been done on light as well as heavy land, and in some cases the cultivating has been 16 inches deep on a river-warp soil, for one of the Directors of the Company.

The practice has been to finish up the work required at the time upon one farm, before engaging for any particular day with another farmer, and the engines have taken for next turn the nearest place without respect to priority of application; and while they have sometimes passed by a little job altogether, they have occasionally caught a single field "on their way," for the sake of "getting coaled" on the journey. Thrashing is merely a resource when tillage-work is not immediately forthcoming. The "slack" seasons are just before harvest, and in "turnip time."

It is optional with an employer whether he will have his work done by the acre, or hire the apparatus at 4*l*. 10*s*. per day. The foreman or engine-driver of each "set" "looks out for jobs," and has a number of "Diary" forms which he has to fill up, leaving a "duplicate" with each farmer he works for; these forms, when collected together, constituting the Company's "Day-book," and acting as a safeguard against dishonesty on the part of the men or of employers. Great praise is due to Mr. Charles Clay for the admirable manner in which every detail of organisation and arrangement has been prepared, and as a guide for managers of Companies yet in embryo, we print the West Riding "Diary" form, and card of prices on pp. 364, 365.

Four men work each "set." The "foreman" has 15*s*. a week all the year round, and 10 per cent. upon the gross earnings of his apparatus, after deducting his own and the other men's wages. The other engineer has 20*s*. or 21*s*. a week; the ploughman, 19*s*.; the porter-man, 18*s*. a week—a high wage, but he must be able to drive the engine if wanted. If more portering be required in a hilly field, the farmer finds the additional help. All four men get either 1*s*. 6*d*., or else meat and beer, from the employer, when they are at work. They are paid well, but then the hours are "from daylight to dark," and they get nothing for "overtime." In the longest slack season the ploughman and porterman are paid off. The 1*s*. 6*d*. per day is a sort of compromise between piece-work and day-work; they are not tempted to rack the engines by over-driving, and they are interested in looking after jobs, and in carefully working the apparatus, because the 1*s*. 6*d*. a day is lost when they are not at work.

THE WEST RIDING STEAM PLOUGHING, CULTIVATING AND THRASHING COMPANY (LIMITED).

Diary. 186 .

Name and Address in full.	Work.	A.	R.	Corn.	Qrs.	Lds.	Rate.	
								£. s. d.

Time at work hours.

Time lost hours.

Examined and found correct. { Employer's signature, or his Agent. }

If this account is paid at the time the work is done sign here.

Paid the above amount,—Signature of Employer.

Received the same for the Co. { Signature of the Travelling Manager. }

No alteration of this account will be allowed after it is signed.

Remarks. Time moving hours.

Company's Office, Corn Exchange Wakefield, 186 .

DR.

TO THE WEST RIDING STEAM PLOUGHING, CULTIVATING AND THRASHING COMPANY (LIMITED).

A.	R.	Qrs.	Lds.	Rate.	
					£. s. d

Received this sum of ..

for the Company.

The following is the Card of Terms:—

THE WEST RIDING STEAM PLOUGHING, CULTIVATING AND THRASHING COMPANY (LIMITED).

Office (at Clay's Agricultural Implement Depôt), Corn Exchange, Wakefield.

BUSINESS HOURS.

Wednesdays .. .. .. 11 A.M. to 1 P.M.
Fridays .. .. 11 A.M. to 4 P.M.

CHARLES CLAY, *Secretary.*

N.B. Orders must be addressed to William Dixon, the Foreman, Royston, Barnsley (who will in all cases arrange the time with the employer when the work is to be executed), and such *orders may be sent under cover to the Secretary, who will forward the same.*

The Company's engines are self-transporting, and do not require horses to fetch any of the machines.

Two engines are used for field work—*one on each headland.*

(List No. 5.) *Prices.* (March, 1866.)

The terms upon which the Company's machinery may be hired are not (*as a rule*) capable of being fixed beforehand—the manager will therefore make *definite* arrangements with each customer taking the following as the basis for the charges for ordinary steam power work.

The engines will not be allowed to work at a greater pressure than 80 lbs. to the square inch, as shown by the gauges on the engines, with 4 furrows in the plough, and 7 tines each way in the cultivator. Work requiring a reduction in the number of furrows or tines will be charged extra, as may be agreed upon.

	£.	s.	d.	
Work done with the cultivator:—				
Breaking up stubbles or seeds and crossing them at the same time—for the two operations .. (Strongly recommended.)	1	0	0	per acre.
Ditto, once over	0	12	0	„
Crossing fallows or steam-ploughed land once over	0	10	0	„
Ditto ditto twice over	0	16	0	„
Work done with the plough or digger:—				
Stubbles, seeds, &c., once over	0	17	6	„

The Company's machinery may be employed by the day, by agreement.

5 per cent. will be allowed of the gross amount for headlands unworked in fields not less than 8 acres. No allowance for land crossed a second time.

Fields under 8 acres will be charged as 8 acres.

The Company will send 4 men for field work, and 2 for thrashing, at the prices given.

The employer will provide the men's board, &c.,* or in lieu thereof, he can pay each man 1*s.* 6*d.* per day—and furnish at his own cost, all the water, coals, and leading of the same, and such other assistance as the work may require (if any) and the requisite coals for the removal to the next place and a signal man for travelling on the road after thrashing.

Prices for Thrashing:—Wheat, 5*d.* per load. Barley, oats, &c., 10*d.* per quarter. The employer is requested to accept, if required, any of the Company's men beyond the two sent for thrashing, at good labourer's wages.

The quantities must be settled before the machines leave the employer, and cannot be altered after the foreman's return is signed.

Every employer (or his agent) of the Company's machinery will be required to sign a return of the quantities of work done, and the amount due for the same to the Company, and no allowance can be made after such return is signed.

(By order) CHARLES CLAY, *Secretary.*

* As this is entirely an arrangement between the employer and the men, the Company will not be responsible on this account in any way.

One important point is that the machinery is inspected yearly by Mr. Charles Holt, Engineer and late Inspector of the Manchester Boiler Association, and his Reports are most valuable, pointing out every detail requiring attention or repair; one, for instance, stating that the lock-up safety-valve of one engine had been "screwed home."

The petty repairs, oil and "management," including sundry small items, but exclusive of rope, renewals of engine, or working parts, and important replacements, have been as follow:—

	£.	s.	d.
1863.—January to June	102	19	0
July to December	113	11	4
	216	10	4

	£.	s.	d.
1864.—January to June	89	6	7
July to December	80	6	7
	169	13	2
1865.—January to June	166	8	5
July to December	104	4	2½
	270	12	7½
1866.—January to June	212	7	7

The great repairs from Messrs. Fowler since the Company started have been:—

	£.
In 1864.—One new rope	84
Repairs to engines	36
	120

And in 1866, say 70*l.* for both items.

The Directors whom we met appeared to think that, in calculating for a "reserve fund," 10 per cent. should be charged for "depreciation," in addition to which there is 5 per cent. interest on capital invested. Steam Cultivating Companies, they say, should be on a large scale, that they may afford to pay a good manager to ride about after several different "sets." The only other alternative for introducing steam tillage to small farms, is for several occupiers to join in the ownership of an apparatus.

All considered that the double-engine winding-drum system is the only one practicable for letting-out purposes, and that the "twin" system will not answer in irregular and small inclosures, even if the men could be sufficiently well drilled and watchful enough to work it.

Mr. Bennett, one of the gentlemen present, had reduced his horses from 11 to 9, in consequence of being able to avail themselves of this machinery. Mr. Moore and Mr. Wilton had also made reductions.

CONCLUSION.

Our Report might be expected to close with a Summary of points believed to be established by the foregoing body of evidence. But as we have, for the most part, avoided tabular synopses of averages, so we feel that a string of pat "conclusions" would be more likely to mislead than to convey a sound impression; and that the reader who will not take pains to refer to the cases where information is given upon special topics of inquiry would not be fairly treated even were we to oblige him with a number of easy generalities. A schedule of "inferences," appropriate enough had we been conducting a

series of experiments or collecting evidence for or against one or two simple issues, would, in the complicated subject of Steam Cultivation, be very much like our Report written over again. And the facts elicited from occupiers of the selected 140 farms, embracing 66,000 acres (probably not one-third of the whole steam-tilled area in the Kingdom) will furnish matter for comment and discussion, by no means to be forestalled and settled off-hand by the present Inspection-Committees.

At the same time we have endeavoured by our Tables at the end of the several "Sections," and by the general arrangement of the farms, to guide readers to the kind of information of which they may be in search: they can refer at once to examples of greatest acreage tilled per day, of lowest price per acre, of greatest proportion of draft-animals displaced, of least number of horses still kept; they will find the "single" and "double engine" systems discussed in the accounts of those farms which employ two engines, and so on.

Those persons who may have expected this Report to pronounce decisively upon the question between a stationary or headland-moving engine, or between one engine and two, will be of necessity disappointed; we find it impossible to separate the choice of a "system" from the circumstances in which it is to work and the results demanded of it. In a general way, we might state our impression that, while advantage is derived from employing cheap light tackle for a few fundamental operations, such as autumn cleaning, greater benefit is realized from a more powerful apparatus that can drive all the heavy tillage-work of the farm: we may say that, for farms of diminutive inclosures (not necessarily small occupations), if you *must* have only one engine, apply it in connexion with the "roundabout" or stationary-engine system; but that, until the useless and encumbering fences are removed, the double-engine system is the best for such circumstances; that, while on clay land, the benefits of steam culture are great enough to warrant the purchase of a single-engine apparatus on a comparatively small farm, small occupations in general must depend upon "partnership" or the "hiring system;" that the tendency on large occupations is to adopt two engines instead of one, for the sake of the time saved; that "partnership" works well in several cases; that the "hiring system" under both individual and partnership proprietors, works well; that the contract business by Companies has been proved remunerative; that, in ordinary steam-working, payment of hands by the day is preferable to payment by the acre; that no insuperable difficulty exists about drilling agricultural labourers to manage the steam machinery: and to this we might add many other points, such as the cost per acre being demonstrated to be of less con-

sequence than the saving of time; that clay land can be flattened and yet drain well, that the annual cost of steam tillage on a farm is generally less than that of the horses it has displaced, and that in most cases an increase of produce, in some instances as much as 8 bushels per acre, has resulted from steam cultivation. We may state, as our general conclusion, that steam tackle, whether of Fowler, Howard, Smith, or other makers, is now so far perfected and settled in form and details that it may be classed among old-established, standard farm-machinery, and no longer among the novelties of the day; that the expenses in repair, wear of rope, etc., are now so moderate as to be amenable to the ordinary estimates of wear and tear made in the case of ordinary implements; that, as a rule, steam culture gives satisfaction to its adopters. For, while more or less of success in economy of tillage or increase of produce, marks almost every instance contained in this Report, the failures or cases of doubtful or neutral result, are easily explainable. So that we have arrived at this general conclusion,—Steam cultivation in the main answers well; and here and there, where anybody has tried it and given it up, we are quite sure from the success of so many men in all parts of the country and under every varying circumstance of soil, situation, and climate, that there must be an explanation of the fact, either in the fault of the manager or the inefficiency of those particular pieces of machinery, not affecting the credit of "steam tillage" at all.

One fact has become very patent to us, that, while farmers in some neighbourhoods have largely followed the example of a successful steam-plough man, in many instances they have considered themselves warned off by the failure of an unsuccessful case. Thus we have lighted upon a large farm of between 600 and 700 acres, under an educated and intelligent manager, where, nevertheless, steam cultivation appears at a sad discount. The greasy clay, with small stone in it, was said to be deep-drained, the pipes lying in solid clay: the steam cultivator had levelled the old high-backed lands (probably much too fast); and we found the farm, during very wet weather, to be in anything but a well-drained condition, water standing in various places. The farmer maintained that that sort of land will not drain if laid flat: there may be soil too tenacious to do this, and, as our Report records, we have found varying pieces of evidence on this point in different localities; but we have our doubts as to the efficiency of the drains themselves upon this particular farm, which certainly does not lie under a remarkably rainy sky. The normal force of 24 horses had been reduced to 16, which we saw at plough, very starved and weak; in fact, the occupier frankly admitted that he last year killed 10 horses with hard work. The crops were

wretched; the turnips very bad and weedy; the corn crops poor: though the ground, in general, was not particularly foul. This we felt to be an instance of farming under difficulties,—a more liberal use of capital being required on a holding, that, we learned, had been cursed with a bad name for generations. Is it likely that steam cultivation could earn any credit under such circumstances?

We have found on a large farm an efficient steam-plough regularly worked for years in association with a monstrous growth of couch on heavy soil, for which no excessive wetness of the climate presented an excuse, and with any amount of inattention to thistles and charlock. On that farm we saw (in September) a field of two-years old seeds which had been "Bentalled" by horses both ways, foul with grass "from the wet," and then waiting "to be burnt." Here, certainly, was a poor specimen of the advantage of keeping an expensive piece of steam-power, which, if of use at all, ought to have tilled and cleaned precisely such a field as this.

We have visited an estate farmed by an agriculturist of some eminence, in whose hands the steam-plough might be expected to shine to advantage,—seeing that there was not the least sign of lack of capital. There was, obviously enough, a want of judgment in the general tillage management of this medium-soil and clay, as well as a want of appreciation of what might be done by the apparatus. The green crops were of moderate quality, most of the so-called "dead" fallows were green and lively with couch and worse grasses, and many of the stubbles were foul. "No wonder," we thought, "if steam tillage extends very slowly, when it has to be answerable for such bad management as this, in the very circumstances where everybody looks for all the results that large farming and abundant resources can realize."

In other cases we have found too much (rather than the more common "too little") demanded of the steam-plough. Sinking men have made a desperate venture upon a costly machine that was to retrieve the condition of their farms, and, as it were, manure the land, stock the land, and do everything else, besides merely cheapening, expediting, and improving the mechanical operations of tillage: the apparatus, being unable to fulfil these delusive hopes, has not raised the prospects of such unfortunate people, and steam culture comes in for blame really attaching to general impoverishment.

It is no compliment to a steam-cultivator for its owner to keep it shut-up for two or three years, from a merely local or perhaps personal cause. Yet we know farms where this is the case: one farmer telling you that he liked the steam-tackle uncommonly well, but has not cared to apply himself to its management since

the death of his son, who had all the direction and control of it; and another affirming that the cultivator had answered his purpose, but now he was wanting good men to "go with it"—we suppose, after losing an engine-driver, or some everyday difficulty of the kind. Yet these very gentlemen acknowledge that neighbours, working similar "sets," got their work so forward last year, and all their land so clean, with other good results in prospect, that the merit of steam culture upon medium soil was clearly and practically demonstrated.

We met with the case of a farm-bailiff who, having saved a comfortable round sum out of his wages, bought a steam-plough and went to work on the letting-out system. But, as described to us, "his men took it easy, and got muddled in the management,—a wet time coming on suddenly, the engine could not be got out of the middle of a clay field, where it stood for four months, and this proved a heavy blow to the poor fellow." Need we wonder that very powerful weighty engines should get a bad name in that immediate vicinity: whereas the machine in distress was a spectacle due to inefficient management, not to the helplessness of a 12 or 14-horse engine in a soft country; because there are numbers of such, in similar circumstances, free from like accidents and laughable ill-luck.

One reason why steam-ploughing does not spread rapidly in the vicinity of very successful examples was thus put by one good manager that we visited:—"Neighbours of mine who could buy my farm to-morrow, but have never spent 50*l.* in guano,—miserly save-alls, devoted to mean savings, investing no capital in remunerative improvements, for want of enterprise and largeness of mind,—are not the men to lay out hundreds of pounds in a machine which they can, nevertheless, see does me good."

We have been to a farm, expecting to see a good example, knowing it to be in the hands of a man of capital, and have been disappointed by finding the several parts of the tackle rusted-up in a back-yard—in fact, laid aside a couple of years ago; and, as far as we could make out, mainly because it began to call for a slight outlay in repairs. How is steam-machinery to make its way, if subjected to such niggardly and suicidal treatment as this?

We have seen expensive steam-tackle standing out in the rain, with not even a tarpaulin covering the windlass, the rope frightfully red-rust-coated on the drums—not in the field where work was left-off and work was to be renewed, but on the farm premises, where the rope-porters and anchors, and pulleys laid there for months, were grown round with grass, because of there being no possible shelter under which they could be put; so pitiful was the accommodation, (there was little also beside a poor barn, tumble-down hovels, and ranges of the vilest thatched sheds in

addition to one or two decently built houses, stables, &c.), afforded by a landowner on a farm of many hundred acres arable.

We have been surprised at the number of farmers who can afford to be careless in their treatment of machinery which cost them so many hundreds of pounds; at the common lack of a house, even on scientifically-planned and architecturally elegant premises, capacious enough and lofty enough, and with a lock-up doorway wide enough and high enough, for the lodgment of an engine or two, with heavy iron-work that requires some elbow-room; to say nothing of the frequent deficiency of a smith's shop, properly fitted and furnished with such things as ratchet-drills, tapping-irons, and other handy tools wanted in manifold little jobs of home-done repair. It is hardly to be believed that the major part of the farmers are negligent of that important member of their apparatus—the rope; not only in deficient attention to portering in the field, but also in not properly dressing the rope before laying-by for the winter. We have seen costly steel rope lying wet and rusting in the furrow, where rainy weather interrupted the progress of the implement weeks and weeks before. This is a piece of unconcern for which no excuse can be found; but, far worse than that, we believe that comparatively few employers of steam-tilling machinery put themselves to the slight trouble of coating the rope with a protective covering against rust, before laying-by for a season. A noted land-agent paralleled this unthrifty appreciation of economy in minor details, by the following example: he has drained six thousand acres of land, finding the tiles, but the tenants defraying the cost of cartage and the execution of the work; yet, strange to say, they allow any amount of weed or mud to seal-up the outlets, so that this agent has himself to send round men to clear the drain-mouths,—the farmers, contented that the pipes have been put in, never troubling themselves even for plans of the drains, in order that they might know where the outlets are.

That steam culture is to a large extent a landlord's question is very evident. An engine cannot profitably traverse the clay lanes and founderous farm-roads that exist upon many estates, and the tenant cannot undertake to make, at his own risk and expense, such permanent improvements as sound hard roads. An engine cannot work in diminutive polygonal or irregular-shaped inclosures, with any of the profit which has been related in the course of this Report; and the tenant cannot undertake to clear away, at his own charge, mile after mile of straggling hedges and primeval copses and spinneys. Much less is it in his power to effect exchanges of slices of land between his landlord and abutting proprietors, in order to get straight field-

boundaries, which are so conformable to the operations of tillage-machinery. The engine cannot earn profit for the tenant upon land in want of drainage; and this surely is a preparation to be provided by the landlord. Steam tillage is obstructed, and the machinery damaged, by outstanding field-timber, and by excessive hedge-row wood, more particularly ash-trees; and the tenant cannot fell these beauties of a bygone age without the owner's sanction. And where tenants are forbidden the use of a reaping-machine, or limited to stubble of a certain number of inches' height, or, if allowed to mow, are forbidden to rake after; where the impositions of a mediæval forestry are laid upon a luckless tenantry, it is simply impossible for steam tillage to be resorted to at all—the very back-bone of which is the earliest upturning of stubbles, as well as winter-tilths deeper and more lightly-laid than the best blood and bone in a hunting-field dare venture to plunge over. We have felt, too, in the progress of our Report, that we have been, of necessity, revealing sources of profit to the farmer, and laying open his gains to the eyes of some unprincipled men, who are ever on the watch for a chance of profiting by labours and investments which are not theirs, who have a sharp eye for a fresh excuse to "send a valuer over the estate," and who are forward enough to "urge," and "advocate," and "introduce" agricultural improvements in this fashion—"Jones, you see, by the Royal Commissioners' Report, that Nokes is clearing at least a pound an acre by steam-ploughing; you had better start too, and so make farming pay better for both of us." It is indeed a bitter position for an enterprising occupier to be in, when any new thing he may discover to make a purse out of has to be held as far as possible *sub rosa;* and there would at once be an end to all agricultural progress if we were to hush up every new means of advantage for the husbandman, lest a greedy proprietary should hastily demand a share in proceeds, which, after all, should be considered not as making the farmer's fortune, but as helping him to retrieve (in many districts at least) a downcast position. Let proprietors do their part in preparing estates for the steam-plough—themselves raising the value of their fee-simple; and then the tenantry will not begrudge the enhanced rent due for the use of more serviceable holdings.

In thanking all those gentlemen who have so disinterestedly furnished the Society with information for the public good, and have at the same time, with considerable trouble and expenditure of time, everywhere received the Society's Inspection Committee with a hearty welcome and a British yeoman's hospitality, we must add an acknowledgment that, in spite of our best endeavours to arrive at the truth, there may still be errors in our statistics and estimates. Our time and opportunities for after-

correspondence with the farmers concerned have barely sufficed for the correction of any misconception, or inaccurate booking of some among the thousand details related to us.

Though all the members of this Inspection Committee append their signatures to this Report, it is right to intimate that every farm visited was not inspected by all. Mr. Robert Leeds and Mr. John Nicholson visited a portion, and Mr. Leeds and Mr. Edward Wortley, a portion; both pairs of Judges being accompanied to all the farms by the same secretary-and-reporter. And a number of farm-experiences (easily distinguished in the Report) have been told merely by abstracting the "replies" furnished to the Society's "schedules" of inquiry.

JOHN ALGERNON CLARKE,
Secretary to the Inspection Committee.
ROBERT LEEDS,
West Lexham, Castle Acre, Brandon, Norfolk.
JOHN NICHOLSON,
Kirkby-Thore Hall, Westmoreland.
EDWARD WORTLEY,
Ridlington, Uppingham, Rutland.

Long Sutton, Lincolnshire,
March 20th, 1867.

Report of the Supplementary Committee deputed by the Royal Agricultural Society of England to inquire into the Results of Steam Cultivation in the Counties of York, Durham, Cumberland, Westmoreland, Lancaster, Salop, Nottingham, Stafford, and Leicester.

First Journey.

YORKSHIRE.—(115) Lord Zetland, Saltburn-on-the-Sea.

DURHAM.—(114) J. Pease, Esq., M.P., St. Helen's; (116) Lord Durham, Bowes Farm, Fence Houses.

CUMBERLAND.—(117) W. Lawson, Esq., Baggrow, near Carlisle; (118) Carr and Co., Silloth, near Carlisle.

WESTMORELAND.—(119) Messrs. Nicholson, Kirkby Thore.

LANCASHIRE.—(120) R. Neilson, Esq., Halewood, Liverpool; (121) Messrs. Horrocks, Toxteth Park, Liverpool.

SHROPSHIRE.—(122) Steam Cultivation Company, Whitchurch; (123) Steam Cultivation Company, Market Drayton.

Second Journey.

STAFFORDSHIRE.—(124) Lord Hatherton, Penkridge, Teddesley Park; (125) Marquis of Anglesey, Sinai Park, Burton-on-Trent.

NOTTINGHAM.—(126) H. I. Wilson, Esq., Newlands, Mansfield; (127) Duke of Portland, Carburton; (128) Capt. Saville, Ollerton; (129) Right Hon. the Speaker, Crow Park, Sutton, Newark; (130) Grosvenor Hodgkinson, Esq., M.P., Balderton, near Newark; (131) James H. Fisher, Esq., Orston, Elton; (132) John Hemsley, Esq., Shelton, Newark.

LEICESTERSHIRE.—(133) Lord A. St. Maur, Walton, Loughborough; (134) Mr. Pacey, Garthorpe, Melton Mowbray; (135) Lord Berners, Keythorpe, Leicester.

No. 114. We commenced our inspection with Mr. Pease's farm at St. Helen's, Bishop's Auckland, Durham. Fowler's 10-horse engine, 4-furrow plough, and 7-tined cultivator, had been purchased in January, 1862, consequently at the date of our visit the tackle had been in use nearly five years. The original cost of the apparatus was 840*l.* The outlay on repairs, skifes, breasts, shares, &c., was 163*l.* 6*s.*; paid for two new ropes 84*l.*, for a new plough-frame 45*l.*; in all, 292*l.* 6*s.*, or upon an average nearly 60*l.* a year. In addition to the above, the original clip-drum, in which the lower rim was held up by bolts, has been exchanged for the screw-arrangement, and the 4-wheel anchor has given place to one with 6 wheels. Mr. Pease having recently let his farm, the tackle was valued at 550*l.* Thus we see that, independently of repairs and renewals, the wear and tear may be calculated at 60*l.* a year, or about 7½ per cent. on the original outlay. It is only right to state that the incoming tenant declines to purchase the apparatus.

The farms occupied by Mr. Pease consist of 300 acres of arable land at St. Helen's, and 140 at Thickley adjoining. The latter, however, has only been cultivated by steam during the last year, consequently our calculations must be based upon work done on the St. Helen's farm.

The soil consists partly of drift-gravel, partly of clay with stones, the subsoil being more or less stony. It is none of it really strong land, two horses being able to plough one acre a day. Unfortunately no journal of work has been kept, and therefore in endeavouring to arrive at the results we must base our calculations upon the ordinary course of cropping. Confining our attention to the St. Helen's farm (300 acres), we find that the following course shift has r[illegible]evailed, viz., 100 acres of wheat or barley, after fallow, [illegible]00 acr[illegible] fallow or green crops, and 100 acres of seeds and [illegible]ts [illegible] roportion of 30 acres seeds and 70 acres oats.

[illegible] are as follows:—

		Acres.
[illegible]00 acres fallow for wheat, 1 plough		100
[illegible]00 acres of stubble for fallow, 1 plough		100
[illegible] ,, 3 cultivations =	Acres. 300	
[illegible] ploughed		70
Ploughed		270
Cultivated		300

Calculating the average work at 5 acres a day ploughing and 10 acres cultivation, we have 84 days per annum for the tackle to work; the cost per day being as follows:—

	£.	s.	d.
*Labour, including water-cart	1	0	4
Coals, 13 cwt., at 7s.	0	4	2½
Oil	0	1	6
†Wear and tear and interest of money at 12½ per cent. on 840*l.*	1	15	0
‡Repairs	0	5	6
	3	6	6½

The annual cost of steam cultivation, therefore, equals 279*l.* 9*s.* 6*d.*, supposing that the whole of the ploughing and cultivating were done by this power; but it was evident, on inspection, that this was not the case, as we found part of a stubble-field, one large wheat-field, and all headlands ploughed by horses. As the area worked by steam is reduced, the cost would be increased; but assuming our calculation to be correct, we shall still see that steam cultivation has not been a direct gain at St. Helen's. The number of horses, originally 14, has been reduced to 8: the cost of the 6 done away with, calculated at 45*l.* each,§ would equal 270*l.* per annum; consequently we have a balance of 9*l.* 9*s.* 6*d.* against the steam. This sum, however, might be amply made up for in increased produce. What is the evidence on this point? Mr. Coates, the bailiff, who has managed the farm for some years before steam was introduced, says that "he cannot say there has been any increase of produce; but the land has been wetter since than formerly—a fact that he attributes to the doing away with the furrows and ridges." The drains are laid 3 feet 6 inches deep, the land is considerably elevated and "sideling;" and Mr. Coates believes that the explanation of this apparent anomaly is found in the fact "that the water, after heavy rain, instead of finding its way into the furrows, soaks into the surface." We can hardly believe this would be the case if the drainage were efficient and deep; yet we are told that when

* Engineer, 4*s.*; plough, 3*s.* 4*d.*; anchor-men, 3*s.*; 2 boys, 2*s.* 6*d.*; water-cart man, 2*s.* 6*d.*; horse, 5*s.*

† *i.e.*—7½ per cent. for depreciation and 5 per cent. for interest of money. We adopt the former rate, believing that it represents most closely the average rate of depreciation on the entire plant. We quite agree in the opinion that, strictly speaking, those portions of the apparatus that are from time to time renewed as repairs should be struck out from the parts liable to be taxed for depreciation. But on those parts, if they stood alone, 10 per cent. would not be too much to charge, and we prefer to arrive at a result by a general charge, which our experience proves to be a close approximation, rather than complicate our Report and trouble our readers with intricate calculations.

‡ 292*l.* 6*s.*, total outlays in repairs from Jan. 1862, to Jan. 1866, 4½ years.

§ According to the nature of soil: we have a pair of horses and attendant at 90*l.* in the case of light land, and 100*l.* on very strong soils.

the drains were opened they were found clear and running well. Altogether it is a puzzling statement, seeing that the land was generally so full of stones that thorough drainage should have been easy.

At first breakages were frequent in consequence of the ploughs coming in contact with fast stones: sometimes as many as four skifes have been broken in a day; latterly the steel skife has been used with marked benefit.

The comparative lightness of the land may be gathered from the fact, that although the tackle has been used for five years, digging has never been resorted to except in one case, the plough being always employed. The fact is that the soil is of a poor hungry character, as was evident from the wretched stubble and very moderate roots. There is but little mineral matter to be benefited by aëration, therefore we find no increase of crop from the use of steam-power.

The wear of the ropes has been considerable, and their quality has been found to vary much. The average quantity of ploughing was formerly nearly 6 acres; but during the last season a plough has been taken off on account of the weakness of one rope. The average depth of fallow-ploughing has been 7 to 8 inches—not greater than formerly with horses.

It is, we think, evident that from the nature of the soil and the comparatively small area for cultivation, together with the breakages which occurred, that steam cultivation has not proved remunerative at St. Helen's. From this example we may fairly infer that land sufficiently light to be ploughed by a pair of horses, and not of a nature to be seriously injured by horse-pressure, will hardly pay for expensive steam-tackle, unless its area be very much more extensive than that at St. Helen's.

No. 115. We next proceeded to inspect the Tofts Farm, belonging to Lord Zetland, where steam cultivation has been carried on since March, 1862. The farm is situated about a mile from Saltburn, on rising ground, much of the land having a considerable incline. The land, 300 acres of arable, is a tenacious red and blue clay, on the ironstone, naturally poor and hungry; some work has been done for tenants, who are allowed to have the tackle on payment of working expenses, i. e. labour, coals, and oil, and 12*s.* a day towards wear and tear—a mere acknowledgment, as will be evident when we come to figures. The tackle consists of Fowler's 14-horse-power engine, anchor, two ploughs (a 3 and 4-furrow), 7-tined cultivator, Croskill crusher, and drag harrow, costing altogether 1165*l.* 19*s.* 5*d.* The repairs and breakages, which, however, principally occurred during the first year, amount to 474*l.* 15*s.* 3*d.* These breakages may be partly attributed to incomplete con-

dition of the machinery in 1862, and partly to the tenacious quality of the land, and the fact that on the hillside the plough was sucked in to such a depth that the resistance became enormous. In some instances it was found necessary to cut out a track for the engine to keep it from being drawn into the field, and it was always indispensable that it should traverse the higher ground; the anchor could not be kept in its place except at the bottom of the field. Previous to the introduction of steam the farm was in a high state of cultivation, having been managed for many years by the present energetic bailiff, Mr. Andrew Stonehouse. The ploughing by horses was as deep as now, viz., 12 to 14 inches, four very strong animals being put to each plough: everything was thoroughly well done. Eleven horses, all in their prime, were then kept; the present number is eight, but mostly aged. No marked *increase* of produce has followed the use of steam, nor is the land *drier* than before.* It is all well drained, but after rain it does not dry more rapidly.

The principal operations are in preparation for roots, which are largely grown in spite of the unfavourable nature of the soil. The advantage of being able to dig up the stubble in dry weather in autumn must be great, and the opportunities for making a tilth, despite natural obstacles, a consideration, when it is determined to have roots, cost what they may. We were told of one field on which steam-driven implements performed 32 operations before the crop was sown. First a deep ploughing with two furrows (the frame carrying only two ploughs); cultivation in spring; Crosskill rolling, dragging and cultivating; these operations being repeated until the surface was reduced to a fine powder suitable for the seed, and a great crop was the result. What the swedes cost per ton, and whether a bare fallow with a commensurate outlay on artificial food would not have proved more profitable, are questions that suggest themselves to the practical man; but roots were to be had, and there can be no doubt results were obtained which would have been simply impossible under horse cultivation. The use of the clodcrusher and drag-harrows combined answers admirably in spring. The deepest cultivation is for roots. The digger with forked breasts is generally preferred to the ploughs. The land for beans, which are largely grown, is dug or ploughed about 7 inches deep. All the land for cereal crops is ploughed by horses; the steam-plough goes too deep and irregularly. The wheat-crops are better after bare fallow than after roots drawn off, although the latter are well manured. On such land the "eating on" of crops would be impracticable except during the height of summer,

* This unexpected fact, upon which Mr. Stonehouse strongly insists, may be due to the removal of furrows. The land must, we think, be more healthy.

and it is not attempted. The roots are sown by the middle of May and carted to the buildings by the beginning of December.

The tenacity and peculiar nature of the land may be gathered from the fact that on the home-farm—it is rare to work more than three of the ploughs, and all the deeper work is done with two. Steel skifes are preferred; the adjustible skifes are found a great improvement on hilly land. After five years of working, we were assured by Mr. Stonehouse that there was no perceptible reduction of draught in doing the same depth. This would be difficult to understand, had not the horse-ploughing been equally deep. We walked over most of the land, and can report that the work was thoroughly well done.

This example is the more interesting from the fact that a daily journal has been kept since September 30, 1863, in which are recorded all the breakages and the actual area worked daily, varying, for digging, from 2 to 7 acres. We give the summary of each year's operations.

	Number of Days.	Area Worked.	Working Expenses.			Remarks.
			£.	s.	d.	
Sept., 1863, to Sept., 1864	127	757·3	185	4	8	Ploughing and cultivating.
Sept., 1864, to Sept., 1865	81	488·2	183	1	0	Principally ploughing.
Sept., 1865, to Sept., 1866	75½	471·0	121	14	5	Ploughing and cultivating.

The working expenses in the above calculation include labour, fuel, and oil. The cost of labour amounts to 18*s.* per day; water-cart horse, 3*s.*; oil, 1*s.* 6*d.*; and coals, on an average, 9*s.*

If taking the average at 91 days per annum, we make an estimate for cost of plant, repairs, &c., somewhat similar to that in the last case, we shall arrive at the following results:—

Expenditure per Day.

	£.	s.	d.
[illegible]ur, including water-cart	1	1	0
[illegible]oals	0	9	0
Oil..	0	1	6
Vear and tear on original outlay, at 7½ per cent. ..	0	19	2¼
ntere[illegible] 5 per cent.	0	12	10
[illegible] per annum	1	14	9
	4	18	3¼

[illegible] [illegible]ltivation amounts to 447*l.*, [illegible] 15*s.* 8*d.* a[illegible] as the expen[illegible] of each operation, and as we [illegible]ave in the catalogue not only ploughing and cultivation, but also [illegible]lod-crushing and harrowing, it must be confessed that the opera- [illegible] admirably done, have proved very costly. The

enormous charge for breakages, which adds so much to the working expenses, must necessarily greatly influence the result. It will be seen from the above that the charge to tenants of 12*s.* a day for wear and tear, &c., is, as was said before, merely an acknowledgment. Notwithstanding this liberality on the part of Lord Zetland, we were surprised to learn that with two exceptions the privilege was little appreciated, although after comparatively shallow horse-work, the results have been more marked than on the home-farm, and increased crops were in some cases clearly attributable to the influence of steam.

Three horses out of the 11 originally kept have been dispensed with, and the account should be credited with their full cost, which on such land cannot be estimated at less than 150*l.* a year.* We have still a balance of 297*l.* a-year, as increased cost of steam over horses, and the question occurs, will the results justify this outlay? The produce does not appear to have been increased, the land is not drier than before, and we arrive at the conclusion that steam cultivation on Tofts farm has not been a profitable undertaking.

We found two capital buildings provided for the tackle, in which it is all housed during winter, a certain extra charge is thus caused, of which we have taken no notice, but this outlay is undoubtedly economical, as the machinery is protected from weather and its durability increased. The travelling-wheels of the engine originally only 14 inches wide, were found too narrow for so heavy a soil, and are replaced by 20-inch wheels. Amongst the alterations we may enumerate a new clip-drum, new anchor, 3 gearing-wheels, and minor tackle. Great expense has been incurred from wear of ropes, which have been entirely renewed. On such tenacious soil, worked so deeply, ordinary tackle was found insufficient, and consequently implements of extra stoutness had been purchased. Thus the 3-furrow plough-frame is a very powerful implement, which it would be almost impossible to break. This strengthening of parts is doubtless one principal reason of the diminished breakage of late, and there is reason to hope that future results may prove more favourable, that gradually the heavy outlay may be considerably reduced, and in the long run the investment prove less unprofitable.

No. 116. Proceeding towards Carlisle, we stopped at Fence Houses to visit Bowes Farm, the property of Lord Durham, at

* Further than this it is only fair to assume that on this very strong land the horses, relieved from all the more exhausting labour, can be kept at a considerable saving; and therefore we may calculate 5*l.* a head on this score, which would swell the total sum on the credit side to 190*l.*

Lambton, where, under the able management of Mr. Steward, his lordship's agent, steam cultivation appears under more favourable circumstances. Until this winter the apparatus has consisted of Fowler's 14-horse engine and anchor, with the 4 and 2-furrow ploughs, 7-tined cultivator, and drag-harrow. Now the use of double-engines, with winding-drums, dispenses with the anchor; and, looking at past results and the favourable character of the land, we think that this change is likely to prove advantageous. The original purchase made in 1862 came to 875*l.*, additional implements have since cost 170*l.*, making a total outlay of 1045*l.* It is a proof of superior management that no serious accidents have occurred, almost the only breakage on record being that of a driving-wheel. Repairs when necessary have been done by the engineers of the collieries, and the "stitch-in-time principle" has no doubt often prevented more serious delays. These are advantages not generally enjoyed by the ordinary occupier; but we would urge on all the importance of securing as engineer a man who is a thorough mechanic, perfectly acquainted with the mechanism of the apparatus, and capable of executing all minor repairs, even though considerably increased wages be necessary to secure such a man.

The soil at Lambton is a strong loam on a clay subsoil, tolerably free from stones, overlying the coal-measures. The home-farm consists of 750 acres, of which about 400 are arable; the apparatus is also employed on two outlying farms about 2 miles from Lambton, which together contain as much more arable land. The fields are much cut up by the working of the collieries, and are not so symmetrical as is desirable for steam culture; they run about 15 acres and upwards; no alteration has been made in their size, and no new roads have been required. The quantity of work per day has varied, according to depth, from about 3 acres, at the greatest depth —13 inches—done by the 2-furrow plough, to 7 acres at 6 to 7 inches. The cultivator (7-tined) has averaged about 10 acres. The average time consumed in moving tackle is half-a-day; the labour required in addition to the ordinary staff being 2 men and 4 horses. The work of the engine has until lately been entirely confined to cultivating the soil, recently it has been employed to drive a stone-breaking machine. No work has been done for hire, but in a few instances land has been worked for tenants, a liberality which is duly appreciated. The engineer fills up his time with carpenter's work or repairing machinery. Mr. Steward has not found the drainage of strong soils improved, or the consumption of the root-crop on the land facilitated; it must be remembered, however, that very deep horse-culture was practised previous

to the introduction of steam. The crops generally are decidedly increased and improved, but no accurate information on this point was produced. The exception is in the case of clover, which is found uncertain and difficult to grow once in 5 years. This may arise either from too much of the subsoil being brought up or, as we incline to believe, from the mechanical condition being too loose. The clover after harvest is generally abundant and forward, but it dies away during winter and spring, and we should recommend folding over with sheep, and thus consolidating the surface, more especially as the headlands which are cultivated by horses, and more or less consolidated, generally produce a good plant. No journal having been kept, we were unable to find out the number of days during which the steam is employed, and can only arrive at an approximate result by reference to the system of cropping and the average amount of work done per day.

The land is farmed on the 5-course shift, seeds remaining down 2 years. Steam culture is now entirely confined to the fallow, for when, in some instances, the clovers were ploughed for oats experience proved that horse labour is more advantageous. We have then 160 acres of fallow. This receives a deep furrow in autumn, with either the common or the digging-breast, and is twice cultivated in spring, the drag-harrows, going a double-tine, between the cultivations. Assuming one-sixteenth of the area to be headlands which are worked by horses, we have the following results:—

150 acres of deep ploughing or digging in autumn.
300 ,, cultivated in spring.
300 ,, dragged a double-tine.

Calculating that 4 acres can be dug and 10 acres cultivated or double-dragged, we find the number of days during which steam is employed, including removals, averages 104.

The expenses per day are as follows:—

	£.	s.	d.
*Labour	0	17	2
Coals, at 8s. a ton	0	6	0
Oil	0	1	6
Wear and tear and interest on original outlay at 12½ per cent. (1045*l.*)	1	5	1
Repairs, estimated at 50*l.* per annum, about	0	10	0
	2	19	9

* Engineer, 3*s.* 6*d.*; ploughman, 3*s.*; anchor-man, 2*s.* 8*d.*; 2 boys, at 1*s.* 4*d.*, 2*s.* 8*d.*; man with water, 2*s.* 4*d.*; horse, 3*s.*; total, 17*s.* 2*d.*

We thus arrive at an annual outlay of 310*l.* 14*s.* Against this we have the cost of 8 horses knocked off—14 horses now doing the work of 22 before. Each pair of horses with their driver, on such land and with such deep ploughing, would cost 100*l.* per annum: consequently, for the above outlay, we have a saving of 400*l.* in horse labour, showing a balance in favour of steam of 89*l.* 6*s.* on outlay, independently of the many advantages appertaining to steam culture on strong land. The character of the operations we saw in progress, the excellent condition of the apparatus, and the evident signs of good management everywhere visible, prepared us to anticipate a favourable result, which our figures, fairly representing the case, bear out. Improvement of produce, ability to perform important operations at the proper season, are important items which may be variously estimated, but must be placed to the credit of the apparatus, and we may fairly conclude that we have in Lord Durham's case evidence decidedly favourable to steam culture, and it only remains for us to point out the causes which have led to this success. Good management, on the part of the employer and the workmen, must occupy the first place; sufficient area to be worked to allow of a reduction of horse labour commensurate to the cost of the apparatus, should come second; and favourable conditions as to soil and surface complete the list.

We would, in passing, call attention to a simple improvement in the engines, consisting of small conducting pipes from the steam-cocks of the cylinders, which convey the steam to the ground so that the driver's sight is not obscured by a volume of steam, the noise of the rushing steam is much deadened, and the risk of frightening cattle, when on the road, materially diminished.

No. 117. From Carlisle we proceeded to Baggrow, an off-shoot of the Maryport and Carlisle line, to inspect the operations of Mr. William Lawson on the Blennerhassett and Prior Hall Farms, comprising together some 460 acres, of which about 380 are arable. Some idea of the variety of schemes entered upon by our courteous host may be gleaned from his circulars:—'Steam Cultivation, Steam Thrashing, Flax Retting and Scutching Mills, Nursery, Fruit and Vegetable Gardens,' added to which he has a manufactory for artificial manure, a system of pumping liquid manure and distribution by hydrants, and interest in butchers' shops at Carlisle and Newcastle.

We first inspected the Prior Hall Farm, a useful tract of strongish land 140 acres in extent, of which 130 acres are arable. The soil, a deep gravelly loam with a yellow clay subsoil, is greatly benefited by lime, which is found and burnt on the

farm, and generally applied in small doses every 5 or 6 years. George Glassbrook, the bailiff, prefers slacking the lime in heaps rather than applying it hot out of the kiln on grass land, unless there is moss to burn up. A marked strengthening of the bones of young stock follows liming on grass, and the clovers are developed. There has been considerable outlay in buildings, drainage, and the construction of new roads traversing the farm at right angles to each other, which must be found very advantageous. Steam cultivation is chiefly confined to working the land for the root-crop, the stubble being "dug" or ploughed from 9 inches to a foot in depth; 3 to 4 acres being about an average day's work. The drainage appears to have been improved and the crops increased, though, as Mr. Lawson commenced farming with steam, it is difficult to estimate these particular advantages. At present no horse labour has been saved, as we found six on the farm, quite enough to do the work. Very fine crops of cabbage are grown, and no expense in manuring is spared. Here, as in other places, we found good crops of swedes, half spoilt from exposure to late frosts. The climate is moist in such close proximity to Skiddaw, and possibly there might have been difficulties in storing at the right season, but, assuredly, it is an extravagant practice to keep roots out when they are ripe. After the stubbles are deeply ploughed or "dug," the surface is ridged by horse-ploughs and thus left all winter, then dragged down, and the steam cultivator worked across the winter furrow. Great improvements have been made, and although the outlay must have been considerable, there is a possibility of a rent being made. We cannot venture to say even as much as this for the Blennerhasset Farm, the principal scene of Mr. Lawson's enterprise—about 4 miles off—containing 316 acres of land, 60 of which are pasture and gardens, and the rest useful arable but hilly and stony, and very ill adapted for steam culture. For such a limited area farm premises have been erected at a cost of 8000*l.*, independent of expensive machinery and fittings. Besides the ordinary accommodation for a farm, we find buildings for making and storing artificial manure, a costly pumping apparatus, and large tanks for liquid manure worked either by steam or water. This liquid is collected from every source, and yet only dresses by pipes and hydrant about 25 acres of grass.* At the time of our visit the fluid was being projected by steam power—"Cain," one of the 14-horse-power engines being employed at this work. There are also well made pits for retting flax, and a commodious

* Besides 8 acres of garden-ground.—W. L.

building for the scutching-mills, bruiser, and seed-rolling machinery. The work-people were here under the instruction of an Irishman, who spoke favourably of the quality of the fibre, greater length being the chief desideratum. It is possible that under careful management the yearly growth of a few acres might be made to pay. The staff includes a chemist who, in a spacious laboratory, is supposed to fill up his time by making experiments and testing any point that requires elucidation. The farm buildings proper include a long shed fitted with slatted floors, and divided into pens for 5 sheep each. The animals appeared healthy and thriving. Under a large covered yard we have stables on one side, and the rest devoted to cattle, principally milch cows—also on a platform, which was rather too short for comfort. The labour to keep all these different departments going must be costly. As far as we can judge, the average weekly wages, including the steam-plough, amounts to 30*l.*, and we fear it is often considerably more. It will be remembered by many that Mr. Lawson advocates a co-operative system, and has declared his intention of giving the labourers 10 per cent. on his profits. No division has as yet been possible, although Mr. Lawson, as far as we could learn, is willing to calculate profit without charging rent, interest of money, &c.

But our present business is with steam cultivation; Fowler's tackle, consisting of 12-horse-power engine and anchor, 5-tine cultivator and 4-furrow plough, was purchased Feb. 2, 1862, at a cost of 820*l.* To this must be added, 7-tine grubber, 70*l.*, water-cart, 25*l.*, total, 915*l.* *Replacements*, grubber, 50*l.*, anchor, 49*l.*, and ropes, 89*l.* 15*s.* Mr. Lawson has kindly enabled us to give an abstract of each year's accounts, save the first, viz., from Feb. 2 to Dec. 31, 1862. We learn, however, that the loss then, as calculated by Mr. Lawson, was not less than 200*l.*

ACCOUNT for the Year ending December 31, 1863.*

DR.	£.	*s.*	*d.*	CR.	£.	*s.*	*d.*
To wages	55	5	3	Scarifying 408½ acres, at 7*s.* 5*d.*	151	1	6
Repairs	47	16	8	Ploughing 21 acres, at 10*s.*	10	10	0
Oil and waste	7	16	0	Harrowing 7 acres, at 3*s.* ..	1	1	0
Wear and tear at 7½ per cent. on (915*l.*)	68	2	6				
Interest at 5 per cent.	[illegible]	[illegible]	0	By balance	62	12	11
	[illegible]	[illegible]	5		£225	5	5

* It will be observed that no coals are charged in this account: assuming them to have cost only 15*l.*, a colliery being near at hand, we have the sum of [illegible]*l.* on the wrong side.

ACCOUNT for the Year ending December 31, 1864.

DR.	£.	s.	d.	CR.	£.	s.	d.
To wages	129	5	8	*Scarifying 405 acres, at 12s. 8½d.	257	7	6
Repairs	118	3	10½	Ploughing 21½ acres, at 10s. 7½d.	11	9	0
Oil	14	14	0				
Coals	16	10	0				
Extra horse labour for shifting	6	8	0	By balance	130	12	6½
Wear and tear at 7½ per cent. on (958*l.*)	68	12	6				
Interest at 5 per cent. ..	45	15	0				
	£399	9	0½		£399	9	0½

ACCOUNT for the Year ending December 31, 1865.

DR.	£.	s.	d.	CR.	£.	s.	d.
To wages and horse labour	166	6	7	Scarifying 512 acres	278	9	8
Repairs	64	3	10	Thrashing	12	19	0
Oil and coals	25	18	9				
Injector	26	5	0	By balance	105	31	0
Wear and tear at 7½ per cent. on (915*l.*)	68	12	6				
Interest at 5 per cent. ..	45	15	0				
	£397	1	8		£397	1	8

It will be noticed that none of the above balances are made on the same plan. In the last we find a new item for water-cart horse, which appears to have been omitted from the previous calculations. Last year the clip-drum and anchor arrangement was abandoned for the double-engine and windlass system, Messrs. Fowler making the exchange on the payment of 800*l.* 9*s.* 6*d.* The value of the new machinery complete as supplied being about 1450*l.*, credit was given for 650*l.* as the worth of the apparatus, which four years before had cost 915*l.* The actual depreciation, according to valuation, was thus 265*l.*, our theoretical calculation being 274*l.* 10*s.*

ACCOUNT for the Year ending December 31, 1866.

DR.	£.	s.	d.	CR.	£.	s.	d.
To wages	153	8	1	Scarifying 360 acres	188	9	0
Repairs	115	13	11	Ploughing 13½ acres	6	15	0
Oil and grease	44	10	7	Thrashing	10	3	6
Coals	39	4	7½	Pumping liquid manure and grinding 74½ days, at 25s.	100	12	6
Cotton waste	2	2	6				
Railway conveyance ..	60	17	2				
Sundries, lodgings, &c. ..	12	4	11½				
Water-cart horse	14	16	0	By balance	317	17	10
Wear and tear and interest on 1450*l.* at 12½ per cent.	181	0	0				
	£623	17	10		£623	17	10

* In this year a great advance is made in the charge for scarifying, and, as much of the land was worked twice over, we are inclined to regard the charge as too high; about 9*s.* would be fairer, and at that rate the loss would be considerably increased.

Conclusions drawn from data so manifestly irregular cannot, of course, be perfectly accurate. Enough may be gathered to prove that up to the present time Mr. Lawson has thrown himself into steam culture rather as a pioneer in the path of enterprise, willing to adventure something in the cause of progress, than as a farmer who has an eye to profit. The nature of the land, both as being very hilly and full of awkward stones and the want of a greater area to act upon, will partly account for the unfavourable result. It should be mentioned, also, that the climate is very moist, the annual rainfall being about 38 to 40 inches.

At Blennerhasset we met Mr. W. Norman, of High Clow, Aspatria, who has had Howard's roundabout system for one year. His farm contains 630 acres of arable, mixed soil. He has cultivated for roots, and also, after roots, for corn: 220 acres were worked, averaging $5\frac{1}{2}$ acres a day, including removals. The tackle consists of 10-horse-power (Clayton and Shuttleworth) engine, windlass, cultivator, and side-harrow—costing 550*l.*; four horses have been put down. The engine is used largely for thrashing. The cost of working each day is: for labour, 13*s.*; coals, 5*s.*; and oil, 1*s.* 6*d.*—total, 19*s.* 6*d.* The charge for wear and tear and interest cannot be so heavy as in any preceding case, so that Mr. Norman may probably make steam cultivation pay. We were assured that the land in winter lies drier than before.

No. 118. From Blennerhasset to Silloth, by road, to inspect the results of Howard's roundabout tackle on the farm of Messrs. Carrs, of Carlisle, who here occupy 414 acres, of which 390 are arable, besides 24 acres of sea-bank. The soil varies from a strong clay to rich loam on red sand. The tackle consists of 10-horse-power engine, windlass, and cultivator: 12 horses have been reduced to 8. Steam cultivation is entirely confined to the fallow-land; usual depth of cultivation, 8 to 12 inches. No work has been done this autumn, as it was impossible to cultivate on account of excessive moisture; and the question here, as elsewhere, arises—Should not a plough be regarded as one of the necessary items? It is quite certain that, in all cases where a plough was employed, a good deal, if not all the autumn-work has been got over; whereas, in most cases where the cultivator only is kept, work was out of the question. The average quantity cultivated per day amounts to about 5 acres.

The apparatus, consisting of a 10-horse-power engine by Clayton and Shuttleworth, with Howard's cultivator, was purchased secondhand in the spring of 1864, at some reduction on its price. No work had been done by it, however, and therefore for the purposes of this inquiry it will be as well to charge 550*l.* as the total outlay. The subsequent repairs have been very

moderate, and are assessed at 6*l.* per annum. The fields are large, the surface perfectly flat, and if the drainage were better the land would answer admirably, as larger areas can be worked without a shift; 70 acres of fallow are worked generally 3 times over, or 210 acres in all in 42 days, the engine being employed an equal time thrashing, grinding, &c. The expenses per day can be easily calculated:—

	£.	s.	d.
Labour: 2 men, 3 lads, and 2 boys	0	12	0
Water-cart and horse	0	4	0
Coals and oil	0	10	0
Repairs, estimated at 10*l.*	0	4	9
Wear and tear on 400*l.** at 7½ per cent.	0	14	3¼
Interest at 5 per cent.	0	9	6¼
Daily cost	2	14	6½

—10*s.* 10¾*d.* an acre for each operation, and an annual expense of 114*l.* 10*s.* 9*d.*, against which we have the saving of 4 horses at 45*l.* each—leaving a balance in favour of steam of 55*l.* 8*s.* 4*d.* The shepherd, who showed us the farm in the absence of the tenant, considers that in dry weather it would be practicable to scarify for corn after roots fed off; but, as a rule, horse-ploughing is preferable. Clover appears to come thicker and the grasses grow more vigorously after steam culture, whilst the surface dries more rapidly than formerly, in consequence of increased depth. The land is fertile, very heavily stocked, great crops result, and the whole appearance was like paying rent.

No. 119. From Carlisle we proceeded to Liverpool, calling on the road at Kirkby Thore, to pay the Messrs. Nicholson a flying visit. We could have wished for more than a scanty two hours, for this interesting case of steam as an auxiliary to horses. However, thanks to the kindness and excellent arrangements of our hosts, we were enabled to take rather more than a bird's-eye view of one of the best-managed enterprises we have seen. Situated on rising ground, 350 feet above the sea, and lying between the Crossfells (whose snow-covered sides stood out in bold relief) and the lesser ranges of the lake district, this holding presents difficulties of climate which are successfully combated; and any deficiency on this score is amply compensated for by the fertility of the soil, which may be described as a rich clay loam on the new red sandstone, interspersed with boulder-stones evidently brought down from the neighbouring mountains. The subsoil is generally strong clay with occasional beds of gypsum, which are worked both as a manure for clover and also for commercial purposes. The Messrs. Nicholson occupy two adjacent farms—one the property of Lord Lonsdale, the other partly their own land

* Deducting half cost of engine.

—in all 780 acres. The former was entered upon six years since, and was at that time in a very neglected state. A field was pointed out where a great crop of wheat—some 60 bushels per acre—had been reaped last harvest, which on entry was in such a poor state that the landlord would only charge for seed and cost of sowing. The whole farm has been drained under Mr. Parke's superintendence, and the old story holds good—the pipes are far too small. Some 18 acres of bog-land have been reclaimed by the tenants, and an excellent job made of it, and very complete farm-buildings erected; the haulage having been entirely done by the tenant. Besides all this Messrs. Nicholson trade in gypsum, which is ground and led to the railway and other places. All this explains the reason why draft horses have not been put down to any considerable extent.

It is always interesting to inspect improvements so evidently profitable as those at Kirkby Thore. Without disparaging the exertions of those amateurs who often lay out largely for the benefit of the less affluent, we cannot but avow the conclusion that such a farm as this must do better service to the progress of steam culture than any amount of eccentric and often wasteful expenditure. The practical farmer (whose interests the Royal Agricultural Society must ever have in view) will be satisfied by a visit to Westmoreland that steam culture, in the hands of an intelligent man, may prove a good investment. Mr. J. Nicholson, being one of the Inspection Committee, had not filled up any schedule, and was not prepared with figures, our report is therefore shorn of statistics. Still we trust sufficient has been gathered to indicate the result, and we have only to add that as practical men we express great satisfaction at all we saw.

Messrs. Nicholson invested in Howard's tackle in May, 1863, to be worked by an 8-horse-power engine (Clayton and Shuttleworth), which they already used for thrashing, &c. The tackle consists of windlass, cultivator, and drag-harrows.

The total cost, including the engine, may be put at 510*l.* The repairs have been trifling, and chiefly done at home; the engineer, filling up his time as farm-blacksmith, looks after little failings. *No rope has yet been renewed.*

Hitherto cultivation or grubbing only has been attempted; but the experience of last autumn, which was too wet for such operations, has shown the desirability of adding a 3-furrow plough; and it is under consideration to make this addition, and at the same time to get more power, and probably introduce a 12-horse-power traction-engine. The 5-course rotation is adhered to with slight deviations, seeds being grazed for 2 years. There are 500 acres of arable land, consequently 100 acres of fallow crop, *for which alone* steam cultivation is employed. Here, again, we find

experience pointing out the portion of the course for which steam culture is most suitable; the deep grubbing once in a course being found sufficient, it practically assumes the character of an auxiliary and relief to horse-labour in the heaviest operations. The fields are neither rectangular nor sizable, varying from 10 to 50 acres, and are more or less undulating. The climate is very moist, and hence Messrs. Nicholson considered that a stationary engine working a windlass would prove more suitable than the traction principle. Originally the farm was much more subdivided; miles of fences have been grubbed. We have alluded to the boulder-stones; these are removed before the steam-tackle is worked, the ploughmen sticking up sticks where they exist; men follow and get them up.

The labour consists of

An engineer, who is also farmsmith	3*s.* a day.
Men at windlass, cultivator and anchors, 4 at 2*s.* 6*d.* ..	10*s.* „
Porter-boys, 2 at 1*s.*	2*s.* „
Half-time water-cart, say	3*s.* „
	18*s.* „

At the present time 6 pairs of very fine horses are kept. Messrs. Nicholson consider that the cultivator relieves the farm of 3 pairs of horses; but, for reasons detailed, this is rather an approximate estimate than an actual result. The ordinary operations on the fallows are as follows:—Autumn and spring grubbings; the drag-harrows being worked a double-tine before and after the spring cultivation; estimating the dragging as equal to one cultivation, we have 400 acres worked; a very moderate estimate. This, at an average of 5 acres a day, gives us 80 days as the time at work. The engine does all the thrashing, chaff-cutting, sawing, &c. Upon these imperfect data we may venture to make a calculation.*

Cost per Day.

	s.	*d.*
Labour	18	0
Coals and oil	7	0
Repairs	4	0
†Wear and tear and interest on 400*l.*, at 12½ per cent.	12	6
	£2 1	6

Or per acre, 8*s.* 3½*d.*; very reasonable for such work; and if 6 horses are really saved we should find a handsome balance in favour of steam merely as to first cost. Now let us see as to

* Messrs. Nicholson state that the average quantity of work per 10 hours varies from 5 acres twice over to 8 acres once in a place, and with the harrows 15 to 20 acres have been accomplished.

† 110*l.* is deducted from outlay for value of engine for other purposes than steam cultivation.

results. Messrs. Nicholson, having so recently drained, cannot speak positively of the effect on drainage; they find, however, that the succeeding operations by horses are decidedly lightened—an evidence of a deeper soil and more even bottom. Roots can now be fed off more easily for two reasons: no horse-treading to cause a pan, and the whole surface is moved, which is not the case with horses. We quote Mr. J. Nicholson's reply as to increase of produce,—"Yes, no doubt of it." The clover-seeds are decidedly more certain, and the produce increased. We saw a remarkably promising show of seeds. With a 3-furrow plough and a more powerful engine—extra outlay which the success of the past fully justifies—Messrs. Nicholson's steam culture will be more valuable than it has proved as yet. We may add that Mr. J. Nicholson was loud in his praises of the drag-harrow, with its chisel-pointed tines, and we can readily believe that to follow the grubber it will prove a very valuable implement.

No. 120. The farm of Mr. R. Neilson, of Halewood, near Liverpool, was next visited. Unfortunately Mr. Neilson was from home, and our information was principally extracted from the bailiff. Fowler's tackle, consisting of 12-horse-power engine, and anchor, &c., 4-furrow plough and cultivator combined, implement-frame for harrows, &c., was purchased September, 1863, costing about 1000*l*. The farm contains 300 acres, all arable. The soil is a strong clay-loam, on the new red sandstone; the land perfectly level, and admirably suited for steam, the fields being now large and rectangular: a strip of gravel, about 2 feet wide, has been put along the upper side of the top headland for the off-wheel of the engine to run on; and in another case a pathway crossing a field has been widened into an engine-way, the implements being made to work on either side by shifting the anchor. Mr. Neilson does nearly all his operations by steam-power, and we were informed that the result was satisfactory. Much ingenuity has been exercised in adapting the tackle to so many purposes. The ropes, instead of being coiled under the clip-drum, are carried rom field to field on a double reel, mounted on wheels; the cost of this was 15*l*. The rope pays out as the frame travels, by merely fixing the end of the rope at the starting-point; this is a great improvement over the ordinary plan of having to pull it all across a heavy field by horses.

The *Implement-frame* carries a variety of different implements, according to the nature of the case. Thus it may be used for dragging only, for Crosskill-rolling, for drilling and harrowing both before and behind the drill; or, as is more commonly the case, the implements can be so arranged as to break down, harrow, drill, and cover, at one operation. This is very ingenious, and on such a perfectly level farm, practicable. We have

the drag-harrows attached to transverse bodkins fore and aft, working on the near side; the drill on two wheels with a double set of coulters on the off side, kept firm by being attached to the bodkins, and incapable of any direction but that of the frame; before and after the drill is a light harrow, whilst a small grubber, which is changed to either end of the frame, obliterates the wheel-marks of the frame-carriage. The depth of the coulters is regulated by weights. The wheat so drilled had a yellow look, attributable partly to the season. The drills were generally well filled, but frequently ran into each other; an unavoidable result even on this perfectly level surface, owing to the impossibility of keeping the implement-frame perfectly straight; in an undulating country such operations would be impracticable. Could the drill be steered independently by a fore-carriage and lever this difficulty might be obviated; and it has been suggested that a broadcast-distributor might be introduced in place of the drill. We understand Mr. Neilson expects to make an improvement in the operation by the use of a marker. We were informed that 10 or 12 acres a day was a fair day's work. The advantage would be not in reduction of cost, but in keeping the horses off heavy land. Besides the implements named, heavier drags are employed, which are worked first when the land is too rough for completion at once. The only work that horses must do consists in ploughing the headlands, drilling the *root-crops*, and horse-hoeing the same. The roots are removed, and manure can be got on by a portable railway. In the former operation 12 yards are cleaned at once, the roots being thrown inwards on either hand; *i. e.*, 6 yards each way; the railway being laid down, work commences from the far-end, and, as fast as the ground is cleared, a man and boy remove the rails, as soon as done with, to the next line, and thus very little time is lost in shifting. All the produce is carted to Liverpool, and manure brought back; and when extra work is to be done, horses are procured at Liverpool. As a rule, 8 horses are kept, instead of 18 to 20 as formerly at busy times. Without knowing the extent to which extra horses are employed it would be impossible to make any calculation as to the monetary result. On such land the being able to cultivate deeply and efficiently, in seasons even the most unfavourable, must be a great advantage. Having carefully inspected the farm, we are bound to say that the fallows were well ploughed, and the grass-land fairly turned down for oats—not of course so regularly as if horse-ploughed, but sufficiently so to allow of a good seed-bed. The farm was formerly worked on the 4-course shift, now it is principally on the 5-course, mangolds and turnips being followed by potatoes and beans. The operations commonly performed may be thus described:—

Roots.—One deep ploughing in autumn, 10 to 12 inches, 4 to 5 acres a day. One cultivation with the same implement, having tines in place of skifes. These tines are so arranged that, by having 4 extra brackets, they cover the wheel-tracks.; on the furrow-side a small frame is bolted on, which allows of the tines coming out beyond the wheel; this appears to be a practical measure, and we are surprised that it is not more common. We were assured that the alteration from plough to cultivator can be effected in a couple of hours. The remaining operations consist in twice dragging or once cultivating, the cost being rather in favour of the drag. Manure is always applied in autumn, about 15 tons per acre, besides artificial manure costing 2*l.* per acre on roots, and 30*s.* on corn and grass. If roots come again in the second year similar operations would be required; but whether this is the regular system, or only an occasional introduction, we did not learn.

Wheat follows roots. The land ploughed 6 inches deep, and the seed drilled by one operation, as described above, in the spring, Crosskill rolled, 15 to 16 acres a day.

The *Seeds* are ploughed for oats, as light as may be, about 8 acres a day, then harrowed and drilled at one operation.

In addition to the above, on an average about 50 acres annually are done for hire. The digging-breasts were used during the first year, but not found so satisfactory as the mould-boards. For stubble-ploughing broad mould-boards—from a pattern made on the farm, much deeper than the American—are used, and very deep cultivation is carried out, thus with 3 furrows instead of 4, 14 inches broad by 10 deep, and with 2 furrows, 18 inches by 12 deep. Occasionally in preparing for roots the Norwegian harrow is used, occupying the same place under the implement frame and attached in the same manner as the drill. It is greatly to be regretted that no accurate accounts were forthcoming, and no information given, by which we could arrive at conclusions as to the profitable nature of these operations which have been so successfully performed. We learn that breakages were frequent during the first year, and we could hardly expect that the various novelties could be made to work without some failures at first. Still, here is a great fact—300 acres of strong land worked without horse-pressure. Does it pay? are the crops increased? and to what extent? Is the amount paid in labour greater than before? That the work can be done under difficulties that have put a complete stop to mere cultivating apparatus is proved by us.

There were other points besides steam cultivation that in- [illegible] us at Halewood. We saw immense heaps of mangolds and swedes stored without straw, except a handful just along the ridge. [illegible] width of one stack [illegible] is 6 yards at base, and the height to top

of ridge the same; and yet, notwithstanding the frost, they were perfectly sound. In the case of mangolds, the long red, with their leaves on, were selected to form the sloping outside, and were very carefully built up with a facing of leaves. The interior of the heap consisted of topped roots.* The secret of success was, doubtless, the exposure to the air preventing fermentation. The corn and hay-stacks are all secured under Dutch barns, cheaply constructed; consisting of four oak-posts well stayed, carrying a light wooden roof, capable of being shifted according to the quantity of stuff underneath—a covering 8 yards by 5 yards, and 8 yards high, costs 20*l.*

No. 121. From Mr. Neilson's we made our way to Green Bank Farm, Toxteth Park, where we had an interview with a Mr. Horrocks, who, with his brother, on some 260 acres of variable land, chiefly light, in two occupations, has worked Howard's tackle, consisting of a 12-horse-power traction-engine by Roby, grubber, with harrow and 3-furrow plough, since October, 1863, and spoke with enthusiasm of the results. The cost of the whole apparatus was 700*l.* The only addition has been 300 yards of rope, not because the original ropes were worn out, but because greater length was desirable. No account of repairs has been kept, but they have been inconsiderable. The fuel consumed is about half a ton daily. The average work is 5 acres of ploughing, and 6 of grubbing. The greatest depth 9 to 10 inches. Seven hands are employed, at a cost of about 17*s.* 6*d.* a day; 5 horses have been put down on the two farms; and we thus judge that in this case, although the acreage is too small to allow of very decided results, no loss has been sustained.

No journal being kept, it is impossible to arrive at accurate facts, but Mr. Horrocks is perfectly satisfied with what has been done, and has found the drainage decidedly improve. The crops have increased considerably. He considers the steam-plough suitable for all operations, and prefers the "round-about" to direct traction, inasmuch as work can be commenced sooner after rain. Last autumn Howard's tackle was ploughing whilst Fowler's was idle, on account of the difficulty of travelling the engine.

From Liverpool we proceeded into Shropshire, to inquire into the results of two steam cultivation companies using Fowler and Howard's systems.

No. 122. The *Whitchurch Steam Cultivation Company*, Mr. R. T. Smith, Manager, arose from a few landlords combining to purchase Fowler's double engines (14-horse power), and apparatus,

* The bulbs are stored with all the roots attached and whatever soil adheres to them, if cleaned they would begin to dry and decay earlier in spring. The same system will answer with swedes.—R. N.

in the autumn of 1863. Their district embraces an area of some 15 miles' radius from Whitchurch, and includes land in Flintshire, Cheshire, and the north-west of Shropshire. The farms are principally of a dairy character. The proportion of arable land is small, and the distance travelled considerable. The Company have power to raise 3000*l.*, in 300 shares of 10*l.* each. Up to the present date only 1720*l.* has been called up, which represents the sum required for the original purchase and expenses in forming the Company. The tackle consists of

	£.	s.	d.
2 14-horse power engines, with winding-gear complete	1190	0	0
Pressure gauges and safety valves, &c.	18	10	0
1 4-furrow plough	80	0	0
1 7-tine cultivator	60	0	0
10 small rope-porters	10	0	0
800 yards of ⅝-inch steel rope	84	0	0
Extra wearing parts, shares	10	7	9
Water-cart and headland rope	30	17	0
4 framed harrow, complete	50	0	0
1 travelling van, carrying vice and stove, &c.	39	15	0
Carriage from Leeds	35	3	6
	1608	13	3

Operations commenced March 1, 1864. Between this date and the end of the year the following work was accomplished:—

Acres			s.	d.		£.	s.	d.
560¼	acres cultivated,	average price,	9	1¼	.. ..	821	15	9
58¾	„ dug	„	16	6¼	.. ..	48	12	4½
26½	„ ploughed	„	12	3½	.. ..	16	2	10
22	„ harrowed	„	5	6	.. ..	6	1	0
667½						392	11	11½

In 1865 we find—

Acres			s.	d.		£.	s.	d.
542	acres cultivated,	average price,	12	1½	.. ..	329	2	0
13	„ dug	„	12	5½	.. ..	8	2	6
44	„ harrowed	„	3	0	.. ..	6	12	0
59[illegible]						343	16	6

In 18[illegible] [illegible] the unfavourable season—

Acres			s.	d.		£.	s.	d.
[illegible]	[illegible] cultivated	[illegible]	[illegible]	[illegible]½	..	170	16	9
[illegible]	[illegible] ploughed	[illegible]	[illegible]	[illegible]¾	..	77	8	0
[illegible]	[illegible] harrowed	[illegible]	[illegible]	[illegible]	..	1	16	0
18[illegible]						250	0	9

[illegible] occupied 73 days, many of which were much [illegible] weather, small fields and frequent moves. Th[illegible] day does not reach quite 5 acres, although

the great bulk was "*cultivated.*" The unfavourable character of the land may be judged of from these facts:—

The Company provide four hands, viz.: two engine-drivers, ploughman, and foreman—the business of the latter being to superintend the work, see that all is in order, and lend a hand where required. The hirer finds hands to move porters (usually one), and leads coals and water. The Company's men receive 1*l.* a week whilst the machinery is out. The foreman gets 1*s.* a week extra. Whether at work or standing still these wages are paid during the working season; at other times, viz., from end of May to commencement of September, and during about three months in winter, the men find work for themselves and are not paid by the Company.

Mr. Smith, the Manager, has introduced a travelling van, which combines a kitchen for the men to cook, eat, and occasionally sleep in, and a travelling workshop (in case of repairs being needed), with duplicates of wearing parts. This appears a very convenient and sensible addition, and has, we hear, been copied elsewhere.

We give the balance-sheets for each year. The first account is made up to December, 1864. The total number of shares issued is 172, making the paid-up capital 1720*l.*

CAPITAL ACCOUNT, 1864.

DR.	£.	CR.	£.	s.	d.
To 172 shares	1720	By amounts paid for tackle	1483	14	9
		,, carriage of ditto	35	3	6
		,, solicitor, stamps, fees, &c.	65	7	11
		,, seal, chest, jack, &c. ..	21	4	3
		,, Messrs. Fowler's harrows	50	0	0
		,, large van, tools, &c. ..	39	15	0
		,, Fowler's men and expenses	17	0	0
		,, printing	2	8	0
		,, carriage of harrows ..	2	5	8
		Balance	3	0	11
	£1720		£1720	0	0

WORKING ACCOUNT.

DR.	£.	s.	d.	CR.	£.	s.	d.
To cash received for field work up to Dec. 30, 1864	372	15	10	By wages	123	3	8
				,, bonus to men	4	0	0
				,, auditors for registration, &c.	5	13	10
				,, printing	1	15	0
				,, management, &c. ..	50	0	0
				,, repairs and oil	65	15	9
				,, by dividend, at per cent.	83	14	9
				Balance	38	12	10
	£372	15	10		£372	15	10

Liabilities.	*Assets.*	£.	s.	d.
None.	By balance brought down	38	12	10
	,, book debts to this date	31	18	0
	,, one pair driving-wheels and sundry wearing parts paid for but not used	18	0	0
		£88	10	10

But the affairs of the Company do not stand as well as the balance-sheet and respectable dividend would suggest. One important item on the debtor side has been forgotten, viz. *depreciation.* We should have had a reserve-fund to provide for a new set of tackle when the present apparatus is worn out, as assuredly it will wear out in due course. Not less than 10*l.* per cent., on tackle knocked about so much, would suffice, and this would about swallow up dividend, balance, and book debts; so that in reality the affairs of the Company at the end of their first year are square, with a small working balance to carry forward—a result which, considering the difficulties to be overcome, is satisfactory, and gives confidence for the future.

Second Year's Statement up to December 31, 1865.

CAPITAL ACCOUNT.

DR.	£.	s.	d.	CR.	£.	s.	d.
To balance in hand, Dec. 31, 1864	3	0	11	By Messrs. Howard's rope-porters	3	4	5
Balance	2	1	10	,, stove and pipe, &c., for van	1	18	4
	£5	2	9		£5	2	9

WORKING ACCOUNT.

	£.	s.	d.		£.	s.	d.
To balance in hand Dec. 31, 1864	38	12	10	By wages	134	3	6
,, cash received for field work up to Dec. [illegible]	320	1[illegible]	0	,, printing, &c.	2	8	6
				,, coals	4	9	3
				,, management, &c... ..	50	0	0
				,, repairs, oil, &c.	43	8	3
				,, solicitors, &c.	3	19	2
				,, bank commission	2	1	7
				,, dividend paid	85	10	0
				Balance	33	9	7
					£359	9	10

Assets.	£.	s.	d.
By balance brought down ..	33	9	7
,, book debts to this date	43	3	9
,, driving-wheels and sundry wearing parts paid for but not used	20	0	0
	£96	13	4

The accounts for 1866 not having been audited, we are unable to present our readers with the exact results, but the following is a close approximation.

Third Year's Statement up to December 31, 1866.

WORKING ACCOUNT.

DR.	£.	s.	d.	CR.	£.	s.	d.
To balance in hand Dec. 31, 1866	33	9	7	By wages, &c.	60	0	0
,, cash received for field work up to Dec. 31, 1866	250	0	9	,, repairs, including new sheets for engines ..	6	0	0
				,, pump and hose, water-cart	7	0	0
				,, new tires and brass bushes to fore-wheels of both engines	22	0	0
				,, cultivator-tines	12	0	0
				,, oil, &c.	16	0	0
				,, management	50	0	0
				Balance	110	10	4
	£283	10	4		£283	10	4

Presuming that the above figures fairly represent the working account for 1866 (the account for wages appears to us small, considering the weather, and comparing it with the outlay in previous years—and we therefore think it must be under-estimated) we have, as the result of three years' work, the sum of 279*l.* 15*s.* 1*d.* paid away partly in dividends, and as balance in hand, to put against depreciation, which at 10 per cent. amounts to about 482*l.* 12*s.* The financial operations of the Company have not, therefore, been hitherto successful. We are now stating the case at its worst: it is probable that the forthcoming accounts will show assets for book-debts, apparatus charged but not used, &c., and these items may reduce the sum to about 400*l.* In pointing out these facts we have no wish to discourage the promoters of this really useful enterprise—difficulties at the start have now been overcome, and it is quite possible, with favourable seasons, to make up lost ground, and to yet show the public that a Steam Cultivation Company may, under good management, prove successful even under adverse conditions. It is encouraging to know that the prejudice against steam cultivation which was commonly felt by occupiers in the district, when the Company commenced operations, has entirely disappeared. During the first season the work was chiefly done for landed proprietors. At the present time about 60 names are on the books. Arriving in Whitchurch on a market-day, we were fortunate in being able to discuss the subject with some half score supporters of the Company, only two of whom were shareholders, and the testimony

as to results was most satisfactory; naturally the most stubborn field in each occupation would be selected for the steam-plough, and the effects on drainage appear to have been very decided. In one case (strong land on a marl subsoil) the land though undrained had become very much drier, so much so that further drainage appeared unnecessary. With regard to cost, the general opinion was that the work could not have been done cheaper by horses, and there could be no comparison as to quality. All agree in considering the special value of steam culture is on the land intended for fallow-crops. The deep stirring 10 to 12 or 14 inches, once in a course, being sufficient to let in the air. Most of the occupations of arable, often under 100 acres, were too small to allow of a reduction in the horses kept, but the strain on them was much relieved, and the work forwarded. In one instance some 50 to 60 acres have been done annually; here 2 horses have been reduced. At the time of our visit work had not commenced, but orders were pouring in on every side, the promise of a favourable season. The arrangement as to work is simple and satisfactory: the country is mapped out into districts, according to roads, &c., and the occupation nearest Whitchurch is the first taken. The work generally extends from the beginning of February to end of May, and from early in September to beginning of December, and with fair weather 1000 acres ought to be worked during those periods. One occupier, a Mr. Ravenshaw, stated that steam culture enabled him to grow good crops of turnips where it was impossible before. Enough has been stated to prove that the Company is well established in the district, and that there is no fear of lack of custom; it is gratifying also to reflect that steam cultivation could only be brought to bear in these farms by means of such a company.

No. 123. The Market Drayton Steam Cultivation Company, Limited.—The apparent success at Whitchurch stimulated the proprietors in the neighbourhood of Market Drayton to do likewise; accordingly a company was formed in the summer of 1865, for the purpose of working Howard's double-engines, Mr. A. Gower being appointed manager. The peculiarity in these engines consists in the boilers being placed at right angles to the travelling-frame; the latter running on three wheels, the front one being in the centre, and each engine being furnished with a winding-drum at either end, to allow of roundabout or direct traction; moreover, by this arrangement the novel plan of working two implements at the same time, but independently of each other, as shown at the last Smithfield Meeting, can be carried out.

The tackle was purchased August 25th, 1865, or rather the first instalment arrived at that date, and the roundabout system was

employed that year. The amount of apparatus will be seen from the following list:—

	£.	s.	d.
2 engines, rope and cultivator..	1302	10	0
1 plough, complete	84	0	0
Lamps, anchors, snatch-blocks, rope-porters, &c. ..	65	4	6
Water-cart, 21*l.*, house on wheels, 45*l.*	66	0	0
Duplicates..	72	10	8
	1590	5	2

The advantage of being able to use either the direct or roundabout systems is twofold. The latter can be set to work earlier in spring, when the headlands are not sufficiently dry to carry the engines, and in the event of an accident to one engine work need not stop entirely. A capital of 3000*l.* in 10*l.* shares was subscribed, of which 1700*l.* has been called up. The soil is mostly strong, and the fields vary very much, and are not generally well adapted for steam. Up to the present time the journal presents us with a melancholy chapter of accidents—principally in consequence of repeated breakings of the coiling-screws attached to, and working the windlasses, and the clutches connected with the road-gear; and it is quite evident, from a careful study of the facts, that these portions of the apparatus were defective in construction. They are now materially altered and strengthened. Unfortunately the failure of last season has prejudiced the farmers against the apparatus, and a long period must elapse before such lee-way can be made up. The arrangements as to labour are very similar to those at Whitchurch. Mr. Gower thinks the engines would move better and not stick fast so much if running on four wheels instead of three. The boilers being transverse appear to advantage on hilly land. When the apparatus first started there was plenty of work to do; but farmers got tired of waiting, and set to work with their horses, and last year the wet season together with the cattle plague much influenced the demand. No accounts have as yet been published; but the following abstract conveys some idea of the present condition of the Market Drayton Steam Cultivation Company, Limited:—

WORKING ACCOUNT from September 1, 1865, to February 1, 1867.

DR.	£.	s.	d.	CR.	£.	s.	d.
To cash for 346 acres cultivated	173	0	0	By wages	145	4	0
,, 96 acres ploughed ..	52	16	0	,, oil and cotton-waste ..	14	13	0
				,, wearing parts	10	0	0
				,, other repairs..	22	15	6
Balance representing loss	180	11	6	,, coals	2	10	0
				,, manager's salary, at 40*l.* a year	60	0	0
				,, sundries and carriage ..	1	5	0
				,, depreciation at 10 per cent., say	150	0	0
	£406	7	6		£406	7	6

For the reasons touched on, we cannot consider this case as affording fair experience of steam cultivation by the aid of a Limited Liability Company.

No. 124. Lord Hatherton's home-farm at Teddesley, near Stafford, contains 400 acres of light land, sand, gravel, and peat. He uses Smith's tackle driven by an 8-horse-power engine made by Massey of Newport. The apparatus was purchased in the spring of 1857, consequently it has been at work for 10 years. 2 cultivators, one with 3, the other 5 tines, are employed. 3 ropes have been supplied; 1400 yards of iron-wire rope first sent soon wore out, as the friction from the sand and stones is considerable. 2 steel ropes of 1000 yards each have been added, and, at the present time, the ropes are much worn, though equal, with care, to another year's work. The original cost of the apparatus is not known, but we may fairly estimate it at about 500*l.* The land is level, the fields rectangular and generally large, varying from 15 to 50 acres. The water-supply particularly good, so much so that there is very little deposit in the tubes, and the circumstances are generally very favourable to success, the principal obstructions occurring from numerous trees which dot the surface of the arable land and cause considerable delay. Owing to the light nature of the soil, accidents are almost unknown, and wear and tear reduced to a minimum, which may be gathered from the fact that, after 10 years' use, the whole plant was valued last spring at over 200*l.* and, according to the figures which we append, it will be seen that the apparatus has already paid for itself. The 4-course rotation is adopted, and steam culture entirely confined to the fallow crop. The ordinary operations consist of a double grubbing in the autumn, first with the 3-tined implement, and afterwards, at right angles, with the wider tool. These operations are not generally very deep, the object being to remove the couch grass to which this land is very subject. The land is then horse-ploughed and left for the winter. In spring it is twice worked with the larger implement, and before ridging receives a final and deeper stirring with the smaller cultivator. This gives us 500 acres as the average annual work. The quantity of work done per day of 10 hours, as well as we could judge, was 5 acres with the 3-tined and 7 acres with the 5-tined implement, and the cost, according to the subjoined statement (see *Expenditure per Day* on next page), varies from [illegible] $10\frac{1}{4}d.$ to $5s.$ $7\frac{1}{4}d.$ an acre.

The annual cost of the steam cultivation amounts to about [illegible] and we are informed that 6 horses have been taken off: assuming that the latter, with attendants, would average on this light land 45*l.* per head, we have a balance of 103*l.* in favour of steam. This is a highly satisfactory result, as we have to credit

the account with the great advantage of expedition in operations, and the greater certainty of the root-crop, attributable to the more moist condition of land cultivated instead of ploughed. This fact has been particularly noticeable. With regard to the wear of the rope it will be seen that the total cost amounts to 148*l.*; supposing 5000 acres have been cultivated and the ropes are now worn out, the cost per acre has reached 7*d.*—a fair average result.

Expenditure per Day.

	£.	s.	d.
Labour (5 men and 2 boys)	0	14	6
Water-cart	0	4	0
Coals, 8 cwts. (at 7s. per ton and leading)	0	4	0
Oil..	0	0	7½
Wear and tear and interest, at 12½ per cent. on 350*l.*,* calculated on 85 days	0	10	3½
Repairs and rope, 25*l.* per annum†	0	5	10½
	1	19	3½

We inspected the farm and were much pleased with the general appearance of the land and the economical management apparent—confirmed by an inspection of the accounts which are very accurately kept. A fair rent is charged for the farm, and, as a rule, a good percentage has been realised upon the capital employed in its working.

Owing to the wet autumn, much less cultivation has been effected than usual. Still Mr. Wootton does not consider that a plough would be advantageous. The land runs naturally to couch grass, and ploughing it in would perpetuate instead of destroying it. Cultivation for barley after roots fed off is not practised, because ploughing the land by checking the weeds allows the crop to get so forward as to smother the weeds. Mr. Wootton considers the advantage of steam so manifest, that he would be quite willing to take the tackle at a valuation supposing he were about to become tenant of the farm, even if the proportion of arable land was only 300 acres, which he thinks the minimum for steam cultivation.

No. 125. We next visited Sinai Park Farm, near Burton-on-Trent, lately taken in hand by the Marquis of Anglesey, after a long period of wretched impoverishing treatment. Steam cultivation here goes on at the same time with, or is preceded by, works of permanent improvement, and the point of great importance is

* 150*l.* deducted for half the cost of engine employed in other work. The durability of Lord Hatherton's apparatus cannot be taken as a precedent, except under equally favourable circumstances, but even in this case our estimate of 7½ per cent. for wear and tear appears sufficiently close, as it leaves 125*l.* of the original outlay of 500*l.* not yet paid off, but represented by stock valued at 200*l.*

† Engine, 10*l.*; tackle, 5*l.*; rope, 10*l.*

whether such outlay can be made to yield a fair interest. At the original rent of 22*s*. an acre, the tenant was ruined, and the land, not deficient in minerals but drowned with water, was reduced to beggary. The work of improvement consists in thorough drainage, grubbing fences, clearing out water-courses choked up, fallowing ⅓ of the land, and erecting suitable buildings. The outlay will probably come to about 20*l*. an acre. Now we consider that steam cultivation has had much to do with all this outlay, the existence of this power may have in this, as it certainly has in other instances, induced proprietors to take such cases in hand, and by vigorous treatment, rapidly to effect a metamorphosis which, under ordinary conditions, would have required years. No one can deny that the more rapidly the transition is made, provided the work is done economically, the sooner will a return be obtained. The farm contains nearly 300 acres, of which 165 acres are arable; more, however, will be added. The soil is a strong drift-clay interspersed with boulders and limestone nodules; the latter, which occur at some depth, are from the mountain limestone, the former, principally on the surface, are millstone grit, whilst the whole overlies the red marls of the new red sandstone, in which occasional beds of gypsum are found. In the original state the surface is extremely wet, although, in consequence of the stones, it drains well.

The apparatus which was purchased in October, 1864, consists of a 14-horse-power traction-engine by Aveling and Porter, a very strong and well made machine, with Howard's windlass and cultivator and drag-harrows. Up to last spring the tackle worked on the home farm at Beaudesert. Since then it has been kept on to the Sinai farm, and did good service last summer in helping to fallow 124 out of 165 acres—doing work on the foul weedy surface which would have been simply impossible with horses. The apparatus does not require special comment; the windlass is driven by a crank shaft and universal joint, the patent sling snatch-blocks are used, and we saw a strong mole draining-plough for the grass land which might be used advantageously, but has not yet been tried. As no journal or separate accounts have been kept, it is difficult to arrive at a correct estimate of the cost of repairs. Porters and anchor sheafs seem most liable to breakage, and it appears to us that the latter are not sufficiently strong. We shall not be far out in charging the cultivating part with 20*l*., and the engine with a like sum. The operations have been confined to fallows, and the cultivator has been used with 3 tines only. The first operation, 8 to 10 inches deep, averages 5 acres a day, the second time over about 6 acres. In the spring the land is stirred 3 and sometimes 4 times. Present

cost of wages is as follows:—1 engineer, 3*s.*; windlass-man and man with cultivator, 2*s.* 6*d.* each; 2 anchor-men, 2*s.* 4*d.* each; 3 porter-boys, at 1*s.*; and a lad for water, 1*s.* 8*d.*: total, 17*s.* 4*d.*, to which we may add 3*s.* for the horse. The fields average about 15 acres, and are rectangular, tolerably level, and well adapted for steam. The condition of the farm was so deplorable that any attempt at regular cropping last year was abandoned, and it was determined to work as much as possible of the filth to the surface, and, had the season been ordinarily fine, the result would have been a clean farm; but, of course, success was only partial,—124 acres were worked all through summer, in many cases the operations being repeated 4 and 5 times. We may fairly assume that something approaching 500 acres were cultivated last year in about 90 days. We could not learn the exact cost of the apparatus, but believe it to be about 700*l.*, and with these premises we make a calculation of the cost per day:—

	£.	s.	d.
Wages and horse	1	0	4
Coals, 15 cwts. a day	0	9	0
Oil, 1 quart	0	1	3
Repairs	0	8	10½
Wear and tear and interest, at 12½ per cent. ..	0	19	5¼
	2	18	10¾

This gives the cost for last year as 265*l.* 0*s.* 7½*d.*, or an average of 10*s.* 7*d.* an acre; a high price it must be admitted, but probably as cheap, considering the quality of the operations, as horse-labour. No information could be obtained as to saving in horse-labour, simply because so many horses are kept for hauling drainage and building materials. 15 to 20 extra horses would have been needed last summer to attempt the working of 124 acres of fallows in the condition of those on the Sinai Farm. We walked over most of the land and inspected the drainage, which appears to answer well. We found the drained land much drier after steam culture than when worked with horses, and we are convinced that the first deep operation by steam is of great advantage to the drainage. Mr. Bestwick, the bailiff, proposes to pay the hands 4*s.* an acre for the future, instead of the day pay—this will cover all labour except water and coal carting.

No. 126. We next saw an example of light land at Mr. Wilson's, of Newlands, near Mansfield. This farm, comprising 1000 acres, of which 900 are arable, was part of Sherwood Forest, and has only been reclaimed from gorse and brushwood a few years. The soil is a mixture of sand and gravel resting on gravel. The surface is undulating, the fields mostly large, averaging 35 acres,

and generally well adapted for steam. The apparatus was obtained from Leeds, May, 1862; an agreement being entered into that, if at the expiration of a year Mr. Wilson was dissatisfied with results, Messrs. Fowler would take it again, repaying Mr. Wilson for the outlay, less a fixed sum for hire; finally the agreement was extended over a second year, the first year's experience not being satisfactory, and then Mr. Wilson, being convinced that steam could be economically used on light land, closed the bargain. These facts are noticed as evidence of a deliberate conclusion in favour of the use of steam on light land.

The particulars of outlay are as follow:—

	£.	s.	£.	s.
10-horse-power engine, 4-furrow plough, 7-tined cultivator, anchor-ropes, porters, &c., carriage from Leeds, and men teaching use, &c.			860	0
Additions:—	£.	s.		
Presser	12	0		
Drag	3	0		
Bow on plough for ditto	2	0		
Skim coulters	1	15		
Stakes shod with iron instead of claw anchor ..	2	0		
Alteration of disc anchor	1	0		
			21	15
Total			881	15

The cost of repairs, including ropes, shares and points, porter-wheels, &c., during $4\frac{3}{4}$ years, equals 249*l.*, or 52*l.* per annum.

700 yards of new rope have been purchased.

The following account of the number of days during which steam was employed for the last $2\frac{1}{2}$ years is valuable.

	Steam Culture.	Grinding, Sawing, or Thrashing.
	Days.	Days.
From the harvest of 1864 to harvest of 1865 ..	86	18
" 1865 " 1866 ..	104	24
" 1866 to January 1, 1867 ..	36	42
	226	84

This gives an average of 90 days per annum cultivating and ploughing, and $33\frac{1}{2}$ days thrashing, &c. Unfortunately we have no record of the actual number of acres ploughed and cultivated during this time, and must, therefore, fall back upon Mr. Wilson's estimate of 4 acres ploughed and 9 acres cultivated; and, supposing the time equally divided between the two operations, we have annually 180 acres ploughed and 415 cultivated. In addition to the ordinary wages (which amount to 11*s.* 11*d.* or 13*s.* 7*d.* per day, according to whether the presser is used, for 3 men

and 3 or 4 lads) the engineer, who acts as foreman, receives a bonus after the following rate:—

	d.	*d.*
Ploughing	1½ per acre, or	2 with presser.
Cultivating	0¾ „	1 if drag is attached.

	£.	*s.*	*d.*
Wages	0	13	6
Water-cart horse	0	3	0
Coal and oil	0	7	8¼
Repairs	0	11	6¾
*Wear and tear, calculated on 731*l.* 15*s.* at 7½ per cent.	0	12	3½
Interest at 5*l.* per cent...	0	8	1½
	2	16	2

Ploughing, 14*s.* 0½*d.* an acre; cultivating, 6*s.* 3*d.* an acre.

The annual cost, assuming our figures to be correct, amounts to 252*l.* 15*s.*

Mr. Wilson is unable to speak positively as to the reduction of horses; but, as nearly as he can calculate, seven have been put down, and the cost of their keep, &c., will more than equal the annual outlay on steam. The result might be still more satisfactory considering the large fields and light land. Save the wear and tear in ropes and shares, repairs should be insignificant, yet we have a formidable sum to charge, which amounts to 1*s.* 9*d.* an acre. Then, again, the quantity of work per day is small. It is true this is only an estimate; but, in every case where verification was possible, we have found the estimate to exceed the reality, and therefore we believe it is fair.

The farm is principally managed on the 5-course shift, seeds remaining down two years. The exception applies to one seed-field, about 40 acres, which is sown with turnips, about June or July of the second year after affording a spring bite, the turnips being followed with oats. The seeds looked well; but this is due to the comparative newness of the land rather than to any influence of steam culture. Operations are not here confined, as at Teddesley, to the fallow-crops, but the plough is used for the ley ground, and for the seed-furrow after roots, and indeed for all kinds of work. Mr. Wilson was the first to introduce a presser, which he finds of essential service in solidifying the furrow, especially in the case of the ley ground. The implement was made out of two ordinary horse-pressers. A strong lad steers and turns the implement at the land's end. Mr. Wilson also uses skim-coulters, which help to bury the grass. The 10-horse engine has generally proved sufficiently strong, but more power would be no disadvantage. After an experience of

* 150*l.* is deducted from the capital account, to represent the proportion of wear and tear on engine for barn work.

five years, and paying great attention to every point, Mr. Wilson considers that, as far as actual cost is concerned, there is *no saving over horse labour*, a conclusion which our figures verify; but there is a great advantage in the better quality of the work, and in expedition. Ever since steam was introduced, the work has been more forward. Then, again, in cleaning land, the rapidity with which the cultivator travels tends to loosen and throw weeds to the surface, and in certain cases a decided increase of crop has been evident. Mr. Wilson has found it difficult to get the anchor forward sufficiently fast when cultivating short lengths. The question naturally arises, would not the double-engine system prove more successful? We certainly are inclined to this opinion, and believe the extra cost would be amply repaid in the greater economy of work.

No. 127. From Mansfield we drove through the Clipstone water-meadows, to inspect steam cultivation at Carburton, one of the home-farms of the Duke of Portland. These water-meadows, comprising 500 acres, laid out on the catch system, are probably the most perfect of their kind in the country. The water is collected in a reservoir of 80 acres, situate on the other side of the town of Mansfield, which receives the sewage of Sutton-in-Ashfield, containing a population of 6000, and flows through and relieves Mansfield, which has a population of 12,000. The average rent of these meadows is 4*l.* 10*s.*, and their value in connection with the large arable farms, on the high ground, is very great. Those nearest to Mansfield, and which receive the first supply, are naturally most luxuriant.

At Carburton we found a very interesting case of light-land cultivation. An area of 2000 acres of arable land affords great scope for steam, and, notwithstanding drawbacks which a riper experience might have obviated, we shall find results which are encouraging. Work was commenced October, 1862. The tackle consists of a nominal 12-horse-power traction-engine, by Richardson and Darley, "Kirton-in-Linsey"—a complicated affair. The engine has proved very unsatisfactory. The repairs for the first 3 years in new fire-boxes, tubes, &c., being enormous. The travelling-gear, wheels, &c., altogether unsuitable—Howard's apparatus, including 4-furrow plough, 5-tined cultivator, and 2000 yards of rope. The fields are generally large, varying from 18 to 120 acres, the land gently undulating—in fact, the conditions are very favourable to steam culture, though, from the sandy nature of the soil, there must be a considerable friction on the rope. With this exception repairs are inconsiderable. The cost of apparatus amounted to about 900*l.*, viz. —500*l.* for engine and 400*l.* for cultivating-tackle. 1600 yards of rope have been bought to replace old rope, and the present

stock will barely last this season, being much worn. The cost of the new rope up to the end of December, 1866, was 71*l.* The total acreage worked is stated to be as follows:—

	Acres.
Cultivated	1900
Ploughed	3600
	5500

The total outlay for ropes has been 142*l.* Assuming the value at present time to be 25*l.*, the cost has been very little over 5*d.* an acre—an expense which will favourably compare with ordinary experience. The average work per day of 10 hours has been—

For light ploughing on level land with 4 furrows ..	7 acres.
" hilly work with 3 furrows	5 "
Cultivating 5 tines	12 "

It was difficult to arrive at the amount of horse-labour displaced, on account of the work done by the farm-horses on the estate; but, after a very careful investigation, we come at the following conclusion, viz.—that 50 horses would be employed without steam, whereas at the present time 30 do the work: so we have thus a saving of 20 horses, and the value of their keep and attendance to place to the credit of the steam cultivating account. The corn is all cut by machinery, and occasionally horses are borrowed from other farms: we have fully allowed for this in our calculation. The average work per annum has been about 850 acres ploughed and 450 acres cultivated, and on these figures we can base our calculations. Assuming the average daily work to be 6 acres ploughed and 11 acres cultivated, we get 180 days as the total time per annum.

On this calculation we have an annual cost of 570*l.*, against which may be placed the cost of 20 horses, and attendants, which cannot be valued at less than 900*l.*; so that, despite the extraordinary outlay for repairs, we have a large profit on the apparatus which we may anticipate to see increased in future seasons.

The cost per day is—

	£.	s.	d.
*Labour	0	17	8
Horse for coals and water-cart	0	3	0
Oil and coals, 15 cwts.	0	9	0
†Repairs (chiefly on engine)	1	2	0
Wear and tear at 7½ per cent. on 800*l.* (¼ of engine deducted for thrashing)	0	6	8
Interest of money at 5 per cent.	0	5	0
	3	3	4

* Engine-man, 3*s.*; windlass-man, 3*s.*; ploughman and 2 anchor-men, 7*s.* 6*d.*; 5 boys, at 10*d.*, 4*s.* 2*d.*: total, 17*s.* 8*d.*

† The amount of repairs, almost entirely on the engine, is altogether exceptional, and proves either that the engine is a thoroughly imperfect one or that she has been greatly misused.

Such appears to be the cost of a day's work, for which we have 6 to 7 acres ploughed, 10 to 12 acres cultivated on land, so light that it can be worked at any season, and on which a pair of active horses would plough 1¼ acre in a day. Favourable as this result is, it might have been improved upon had the engine been more suitable. In May, 1866, in reply to questions asked by the Highland and Agricultural Society, it was stated that accidents had occasioned, on the average, delays of 3 months annually, often at the time when work was most pressing. Since May, 1866, 420 acres were ploughed and 390 cultivated, notwithstanding the wet season. We found the machinery in operation ploughing after a root crop eaten on. The furrows were laid with great regularity, and barring the breaking of a rope which caused a delay of half an hour, the progress was satisfactory.

No. 128. From Carburton we proceeded to Rufford, near Ollerton, to inspect another case of light-land cultivation. Mr. Somerville, on behalf of Captain Saville, purchased Fowler's 14-horse-power engine and anchor, with 4-furrow plough and 7-tined cultivator, September, 1864.* The farm contains 1421 acres, of which 699 are arable, principally a light sand resting on sandstone-rock. The fields are generally suitable, ranging from 10 to 50 acres. Some of the land is rather heavy, and in such cases difficulty has been experienced in travelling the engine on the headlands; to obviate which it is intended to make roads where necessary. Mr. Somerville expressed a strong conviction that the diameter of the wheels should be increased 2 feet, believing that this would greatly lessen the risk of sticking in the mud. The results, up to the end of 1866, are as follows:—

From September, 1864, to November 10, 1865:—
801 acres cultivated.
60 „ ploughed.
Cost of above for labour, coals, &c., 3*s.* 5*d.* per acre.

From November 10, 1865, to December 31, 1866:—
311 acres cultivated.
[illegible]63 „ ploughed.

The small proportion cultivated in 1866 is due to the fact that, in consequence of the wet autumn, no work was done, as it was found impossible to clean the land. The repairs have been extremely small, with the exception of 10*l.* on a driving-wheel, caused by a sinking of the engine in a sand-road, and the breakage of clip-[illegible]m-bush through not being fluted to admit oil. Nothing has been required but shares and porter-pullies, and Mr. Somerville

* This was the [illegible] Newcastle Meeting of the Royal Agricultural [illegible] of England.

estimates the annual repairs at 7*l.* on tackle, and nothing has been as yet required for the engine. This is a very satisfactory account, and can only be attributed to good management and the purchase of the apparatus when experience had brought every part to the requisite strength.

Original cost was as follows:—

	£.
Engine, 14 horse-power	614
Anchor	55
Plough	90
Cultivator, 7-tined	70
800 yards of rope	84
20 porters	25
Water-cart	20
	958

One set of clips was purchased last spring. The average per day of 10 hours has been—of ploughing 6 acres, cultivating 10 acres. The cost per day may be arrived at—

	£.	s.	d.
Labour	0	15	0
Coals and oil	0	10	6
Repairs, say	0	5	0
Interest and depreciation at 12½ per cent. on 958*l.* for 70 days ..	1	14	0
Cost per day	2	4	6
Annual cost	155	15	0

10 horses have been displaced, the cost of which cannot be estimated at less than 450*l.*; therefore the use of steam at Rufford has resulted in a clear saving of at least 250*l.* per annum. In addition to which we have very decided evidence from Mr. Somerville as to the improvement in the crops. We saw the apparatus at work, ploughing a bean-stubble for roots, the work was being done well. The anchor has 2 spreads, according to the length of rope out: fields of 200 yards can thus be cultivated—a point of considerable importance. We found the engineer and the working parts of the engine entirely protected from weather by a tarpaulin stretched over a framework resembling a waggon-tilt—a sensible addition. This completes our light-land examples.

No. 129. Crow Park Farm, Sutton, the property of the Right Hon. the Speaker, was next visited. This farm, consisting of 400 acres arable and 175 acres grass, was taken in hand at Lady-day, 1863, being then much out of condition. Clayton and Shuttleworth's 10-horse-power engine, and Smith's cultivating apparatus, consisting of windlass, 3 and 5-tined cultivators, 1400 yards of rope, snatch-blocks, porters, &c., were purchased at a cost of 520*l.*

The soil may be described as a strong brick-earth on new red sandstone, naturally heavy land and difficult to cultivate with horses. The calculation extends from the date of purchase to Lady-day, 1866, three years, when the farm was let and the apparatus taken by the new tenant at a valuation: 350 acres were cultivated each year—6 acres a day being the average of operations, including removals. No new rope was purchased during the three years. The original outlay for 1400 yards supplied with the tackle was 61*l.*; the value last Lady-day 20*l.*: which leaves 41*l.* to be distributed over 1050 acres of work, being an average of 9*d.* an acre. The amount to be paid by the incoming tenant is not yet quite arranged; but, supposing the apparatus to be worth 400*l.*, and its excellent condition seems to justify such an estimate, we have as the result of 3 years' work a depreciation of 120*l.*, which approximates closely to our allowance of 7½ per cent per annum. Now as to the saving of horses, Mr. Wilkinson, the tenant, considers that without steam 5 extra horses would be necessary—he keeps 10 now; and, looking at the stubborn nature of the soil, we agree with his valuation: indeed we think the calculation well within the mark. These 5 horses would cost 225*l.* a year, and this sum may be placed to the credit of the steam-cultivator. Cost per day:—

	£	*s.*	*d.*
Labour	0	14	7
Coals, 7 cwts. at 12*s.* a ton	0	4	3
Oil	0	0	8
Repairs (7*l.* 4*s.* 6*d.*)	0	2	6
Wear and tear, calculated at 7½ per cent. on 520*l.* (57 days)	0	13	8¼
Interest of money, at 5 per cent.	0	9	1½
	2	4	9¾

Cost per acre, 7*s.* 2*d.*; cost per annum, 125*l.*; cost of horse-labour saved, 225*l.*: clear profit on steam, 100*l.* per annum.

Now this appears to us an exceedingly satisfactory result. Here is a farm taken in hand after years of mismanagement: draining and buildings done without extra horse-power; the land cleaned in a manner and with an expedition that with horses alone would have been impossible; those who knew the land formerly are astonished at the result. The tenant informs us that taking the apparatus was a perfectly voluntary act, and it is right to notice this fact as confirmation of the evidence already adduced of success. We did not see the apparatus at work, the [illegible] not being sufficiently dry; but the condition of the windlass and engine proved how well it had been managed, and how little the worse it was for wear—not a shilling has been expended on [illegible] windlass, and the brasses and bearings appeared as good as [illegible] The following particulars of repairs may be interesting:—

	£.	s.	d.
New cultivator, wheels, rope-porters, snatch-blocks, &c.	12	19	7
Repairs of various bolts, anchors, beetle-hoops, &c. ..	4	0	0
Cleaning tubes of engine	3	3	11
Carpenter's work, estimated at	1	10	0
	21	13	6

Smith's cradle porters are found efficient; not being so rigid as most, they adapt themselves to the varied strain of the rope, and are not so liable to be turned over. The windlass, made by Buttlin of Northampton, is on 4 wheels, heavy to move on wet land. It is worked by double gearing with reversible break, carrying adjustible pressure behind: we do not think this arrangement so perfect as the blocks in Howard's apparatus. Notwithstanding the wet autumn, a good deal of the fallow land was grubbed; and we had an opportunity of comparing the condition of land so stirred with that horse-ploughed, and found a great difference in favour of steam. It appears to us that Smith's implements break up and open the soil in a manner superior to Howard's cultivator, and this may partly explain the greater advantage following their use. At Crow Park Farm a stale furrow is found very essential for the root-crop; the ordinary process consists in cultivating either once or twice in autumn, cleaning the surface if required, and throwing the land into high ridges by horse-ploughs. This, however, on a large scale, would be more efficiently and economically effected by steam. In spring, before turnip-sowing, these ridges are levelled with harrows, artificial manure is sown, and the land "bouted" up and drilled; and such treatment ensures a splendidly deep and fine seed-bed, in which the roots are certain to strike well and grow away.

No. 130. From Sutton the Committee proceeded to Balderton, near Newark, where Mr. Grosvenor Hodgkinson, M.P., employs Fowler's clip-drum apparatus on a farm of 730 acres, 680 of which are arable, consisting principally of a strong lias-clay, resting on limestone, with some black moory land. The investment was made in August, 1862; the land, then recently occupied, was in a very rough state, to which may be partly attributed the heavy outlay for repairs. The accounts extend over the three first years—viz. from August, 1862, to the end of 1865. Unfortunately for us, Mr. Hodgkinson's parliamentary duties prevented a meeting, so we were unable to obtain much information that would have been interesting. The repairs, including one new rope of 500 yards, amount to 282*l.* 5*s.*—a new clip-drum and driving-wheel having been required. A new road has been constructed right through the farm, and the engine can thus travel on a firm surface—a point of material importance, though involving an outlay which few tenants could safely undertake. We

found the engine working on a headland by the side of this road, an unnecessarily high fence preventing the use of the road. This might easily be lowered without materially reducing its utility.

The horse-labour has been reduced from 23 to 15. The land is managed principally on the 4-course rotation, and the average annual work, as nearly as we can calculate, consists in 330 acres cultivated and 380 acres ploughed. The amount of work per day, including removals, has been 5 acres ploughing and digging, and 9 acres cultivated:—

	£.	s.	d.
*Labour	0	13	10
Water-cart horse	0	3	0
Coals, 17 cwts.	0	13	7
Repairs (calculated for 3 first years) 94*l*. 1*s*. 3*d*. per annum over 113 days	0	16	7
Wear and tear, at 7½ per cent. on 960*l*.	0	12	9
Interest of money, at 5 per cent.	0	8	6
Total day's work	3	8	3

Total annual cost, 385*l*. 12*s*. 3*d*.; less 20*l*. for use of engine thrashing 40 days = 365*l*. 12*s*. 3*d*.

The cost of 8 horses with attendants displaced by steam cannot be estimated on such strong land under 100*l*. a pair; consequently we may fairly credit the account with 400*l*., which results in a trifling balance in favour of the apparatus—with an ordinary amount of breakage, this would have been a good case. The new road must be regarded as a permanent improvement, for which the tenant would willingly pay 5 per cent. The wheat appeared healthy, the ground covered with rough clots, the land generally very clean; drainage is believed to be much improved from the deeper condition of the surface-soil. The land is kept flat, and no water can be seen lying on the top. Bare fallows are replaced by roots, and consequently a heavier stock can be maintained.

No. 131. At Orston, Elton, Notts., Mr. Fisher shows what can be done on the strongest description of lias-clay; not so much in the way of reducing horse-power, as in allowing an alteration of cropping with a view to an increased sheep stock. Before steam cultivation, root-crops were unknown; the bare fallow prevailed, and the sheep were wintered out: now mangolds and cabbage are largely grown and consumed by the sheep in yards, whilst spring vetches occupy a considerable breadth of the fallows, and are eaten off early in autumn, in time for a bastard fallow. The farm contains 700 acres, half of which is arable. The apparatus consists of 10-horse-power engine, by Clayton and Shuttleworth, and Howard's windlass and 5-tined cultivator, &c., costing 550*l*.

* Engineer, 3*s*. 4*d*.; ploughman, 2*s*. 10*d*.; anchor-man, 2*s*. 6*d*.; 2 boys, 2*s*. 8*d*.; 1 with water-cart, 2*s*. 6*d*.

Mr. Fisher being from home, we were unable to obtain any statistics as to the cost of repairs. The principal work appears to be the autumn cultivation of the fallows and preparation of bean land; a considerable acreage of *winter beans* is sown, and we may fairly say that their growth would be impossible without steam. The cultivator is seldom used in spring; its first task being on vetch-stubble, which is thoroughly worked in preparation for wheat. The seeds are always broken up early (before harvest), and receive 2 cultivations for wheat. In 1866—which was a very unfavourable season for cultivation—102 acres were worked, and we may estimate the average annual work at 200 acres. The question naturally arises, Would not a 3-furrow plough have proved a valuable addition, and been amply paid for by the reduction of 2 more horses? At present Mr. Fisher has only taken off 4 horses, keeping 10 now instead of 14. Our experience, especially upon strong land, leads us to the conclusion that it is desirable to be able either to cultivate or plough; for, although in a dry season the former work is most advantageous, it is of great importance to be able to plough in such a season as that of 1866.

We walked over the farm and inspected the crops and stock, and have seldom seen strong land in such a healthy and fertile state. The fallows were dry, the wheat strong and tillering, and the mangolds large, and the whole farm particularly clean. The land is all drained efficiently, and decided advantage has accrued from steam culture, in a drier healthier surface. The alteration of croppings rendered possible by steam culture has been already touched upon, but it is so important and prominent a feature on this farm that we must allude to it again. Granting, for the sake of argument, that the corn-crops are not materially increased; granting that the roots cost as much as they are worth; still the drawbacks from shifting a flock, with either change of ownership or loss of proper supervision, is very detrimental to the breeders, whilst to consumers the benefit arising from increased production is evident. But we are inclined to believe that the judicious growth of roots and vetches must result in an increased corn-produce. In confirmation of this view we have the evidence of an attentive critic, who was at first greatly prejudiced against the apparatus, but from observing results has now entirely changed his opinions, and tells us that he never before saw 160 acres of wheat so even and productive on any one farm, and the appearance of the stubbles that are still open bears him out. We found the ewes running at large on the grass-land, whilst the hogs were living in open straw yards and eating pulped mangolds and chop, consisting of peas and oat-straw with cotton-cake. All the stock looked well.

No. 132. The question—an important one—is often put, What is the requisite size of a farm to ensure a profitable result? Our visit to Mr. Hemsley, Shelton, Newark, tended to elucidate this point. The occupation now consists of 206 acres *—138 arable and 68 grass. The soil is a clay-loam resting on red marl—a very fertile soil, naturally sufficiently tenacious to grow wheat and beans, and yet not too strong for root-crops, though the latter are somewhat difficult to eat off. We have said that the soil is naturally fertile; its productive powers are stimulated to the highest degree by very forcing treatment—a large quantity of cake and corn are consumed, an immense head of stock kept, and great crops of corn grown—so that in reality the produce represents a much larger area, according to ordinary management. The fields vary from 10 to 25 acres, averaging about 14 acres. That it is possible, under such circumstances, to employ steam cultivation without an actual loss, depends upon the economical and constant use of the engine for other purposes —thrashing, driving barn-machinery, &c. This is done at Shelton in a manner which it would be difficult to improve upon. To show that we are justified in deducting four-fifths of the cost of the engine as chargeable to other work, we venture to give a short account of its other operations and of the premises on which these are carried out.

Description of Mr. Hemsley's Premises.

The engine-house is placed at the middle of the cross section of a T-shaped barn, directly in front of which is the thrashing and dressing machines for corn; the longer part of the barn being the space for straw. The portable engine used for cultivating is a 10-horse power, double cylinder, bought of Messrs. Tuxford in 1858.

A short belt from a small pulley on the engine-shaft works one of Appleby's pumps (this belt is thrown off and on without stopping the engine), which supplies a wrought-iron tank placed on the roof of the engine-house, containing about 4000 gallons. A heavy belt, 50 feet long, running very slack, drives the shafting, 40 feet long, which runs through the barn-mill, cutting, and mixing places, and is divided into five convenient lengths—two being to the right and two to the left of the main pulley. These pieces of shafting, being connected by clutches, can readily be put in and out of gear, and can be used separately or in conjunction.

The middle length has only the driving-pulley upon it; the one to the right has three pulleys for driving the thrashing and corn-dressing machines. The engine has power to thrash and

* At the date of purchase, Mr. Hemsley occupied 170 acres in addition to his own farm, which it was contemplated to cultivate.

dress for market from three to five quarters per hour of a bulky mown crop of corn, and to cut up at the same time about two-thirds of the straw. The 2nd length of shafting to the right has three pulleys upon it: one drives Richmond and Chandler's large-sized straw-cutters, fixed at right angles close to the top of the straw-elevator; another pulley, with a light belt, works a chaff-riddle and screen under the cutter; and a third pulley is for driving Bentall's pulper.

The 1st length of shafting to the left runs across the bay of the barn in which the corn is unloaded for thrashing, and in the centre of it is fixed a pulley to drive a portable saw-bench. At the end of it is the mill-pulley for driving a pair of 4 feet 6 inches grey stones; and the 2nd length of shafting, to the left, drives a cake-breaker, linseed rollers, and a chaff-cutter, by Cornes, for cutting hay for cart-horses, which falls convenient for the stables.

By the position of the straw-cutting machine very little labour is required to move the straw from the shaker into the machine. This machine is supplied with three simple means of throwing it in and out of gear. The screening of chaff is found of great use in taking out a large quantity of dust and dirt, which would otherwise go into the stomachs of the cattle; the screen delivers the cut straw at the end of the mixing place, a pipe from the water-tank runs overhead, by which the chaff is always moistened with a dilution of rape-cake. The carts containing roots (which were cabbages when we saw them) are shot up close to the pulper, and are put into it by a woman with a hand-fork. The pulp falls into the middle of the mixing-place and by one movement is mixed with the moistened chaff.

The food is thrown into a waggon lowered into the centre of the place from a tramway of light metals, which are placed above the heads of all the cattle; the waggon when filled is raised in a very simple way by means of a counter-balance to the tramway, and a turn-table allows two lengths of sheds and boxes containing 50 beasts to be fed in less than 15 minutes. The water pumped by the engine into the tank is conveyed by iron pipes to these cattle.

A small wrought-iron cistern is fixed under the tank, and by means of a ball-cock keeps all the troughs about the premises at the same height. Most of the premises are spouted into the well: the natural water is extremely hard.

A pipe with tap from the main tank conducts the water into a feed-tub under the engine, which supplies it exactly at the rate that the engine requires; the tub is thus always kept full: the exhaust steam keeps the water nearly at boiling heat before it is forced into the boiler. In practice this is found of great service, the supply and demand being so nicely regulated that they will

work together a whole day without being altered. A steam-tap inserted into the man-hole of the engine conveys the steam by a pipe into a joining place under the tank for the purpose of cooking roots, &c., for pigs. After the engine is done with at night or at dinner hour, a good supply of water being left in her and about 10 lbs. of steam; pulped roots are cooked in one of Ames and Barford's revolving root-pans for pigs. This pipe is also connected with one of their boiling-pans; these pans and wooden cisterns for mixing pigs' food are supplied with water from the tank above without any labour.

When the engine is at light work the mill-stones are put on, and these are used almost daily for grinding for hire when the farm has no requirements.

It has been the practice here for several years to use about a wine-glassful daily of Lefranc and Co.'s anti-incrustation fluid in the water for the engine, which is naturally extremely hard and strongly impregnated with gypsum; it is thought to be of great service, the tubes having stood six years without requiring drawing.

The coal-store has an opening close to the engine. A small trough at the corner of this place is kept full of water, which is used to damp the coals when broken small; they are found in this state to be more serviceable, especially when they have been under cover a long time.

Mr. Hemsley uses Howard's apparatus, consisting of windlass, cultivator, 1400 yards of rope, &c., and Tuxford and Co.'s 10-horse double-cylinder engine. The engine was bought in 1858 in anticipation of steam-cultivation, which was not commenced till the autumn of 1862. The wearing properties of the engine are highly spoken of, the repairs have been moderate, not a new bearing has been required, and the wearing parts are as perfect now as when turned out. One great reason for this satisfactory condition of things is, that the pressure of steam is never allowed to exceed 60°, it being considered better to reduce the work done by taking less ground, rather than overtax the engine.

Owing to the small area the cultivating-apparatus is little the worse for wear. The original rope is still in use and likely to last for some years, and no serious breakage of any kind has occurred, nothing more than the occasional overturning of a porter and the necessary [illegible] The cost was

	£.
Eng[illegible]	300
[illegible]	200
	500

The only articles from the manufactory are points, the cost of which will not exceed 3*d.* an acre. The average work per annum has been from 100 to 120 acres, partly with 3 and partly with 5 tines in the cultivator, and mostly twice in a place, *i. e.* 50 to 60 acres of surface. The steam is almost entirely confined to autumn cultivation. Here, as at Sutton, it is found desirable in the case of the fallow-land to throw the surface into deep ridges before winter, and *the fine surface is never again buried.* In 1866, notwithstanding the wet season, the apparatus was at work 14½ days, during which 55 acres were twice stirred, making 110 acres, at an average of 7½ acres a day; the cost per day as follows:—

	£.	s.	d.
Labour:—			
Engineer	0	3	4
2 anchor-men, at 2*s.* 6*d.*	0	5	0
1 ploughman	0	2	6
Windlass-man (one-armed)	0	2	0
2 boys, at 8*d.*, porters	0	1	4
1 boy partially employed pumping from wells ..	0	0	6
	0	14	8
Coals, ½ ton, at 15*s.*	0	7	6
Oil..	0	0	6
Repairs, estimated at	0	5	0
*Wear and tear on 260*l.* at 7½ per cent.	1	6	10½
Interest on 260*l.* at 5 per cent.	0	17	11
	3	12	5½

According to the above figures, the annual cost of steam cultivation amounts to 52*l.* 11*s.* or 9*s.* 6*d.* per acre. On so small an area it has not been possible to materially reduce the number of horses kept, and we think it must be conceded that where there are only 5 or 6 horses, steam cultivation will not prove economical in this respect; but the neck of the work is broken, operations are performed that horses could not effect, expedition is ensured at seasons when despatch is all-important, and alterations are made in cropping, especially with regard to the fallow-crops, which could only be effected, without steam, by extra horse-power; and it is not too much to say that to obtain stolen crops of vetches, to be followed by turnips—to properly cultivate so large a proportion of cabbage and mangold as is required for the large head of sheep-stock and cattle that are wintered—one additional horse would be required, and the cost of this horse would fully equal the cost of steam culture. The question, then, to be solved is, whether this outlay has been justified by improved produce. Having carefully inspected this

* This sum of 260*l.* represents the cost of the cultivating machinery, plus ¼ of the engine. The remaining ¾ being charged to the various departments for which steam is continually employed.

farm, we are prepared to state that we have never seen land cleaner or in higher condition, and an extraordinary head of stock is kept. Thus on the 206 acres 152 Lincoln ewes are lambed down, and the produce sold out at 20 months old, and about 60 head of cattle kept. Such a favourable result on so small an area is only rendered possible by the economical use of steam-power for other purposes; and we come to conclusions that Mr. Hemsley's experience is too exceptional to build upon, and that from 250 to 300 acres of arable land is the smallest area on which it would be prudent to employ steam cultivation. In draining this strong soil Mr. Hemsley has made several wells, 4 yards deep, at convenient spots, to do away with the expense of carting water. These wells cost about 30*s.* each, are covered with a square stone, and are simple and practical, not only valuable for steam cultivation and watering cattle in summer, but of benefit to the drainage as reservoirs for silt and air-holes.

No. 133. At Lord A. St. Maur's home-farm at Walton, Howard's apparatus has been at work since 1862, and is well spoken of by Mr. Mountstephen, the bailiff. We have a 10-horse-power engine, by Clayton and Shuttleworth, 5-tined cultivator, chisel-harrows, and 3-furrow plough—the latter being found particularly useful in a season like the last. The expense of repairs has been absurdly small. The engine has never cost a shilling, and the bailiff would undertake to keep the whole concern in order for 10*l.* a year. One new rope (800 yards) was bought last autumn, and the remainder has been renewed since; so we can easily calculate the wear and tear of ropes from 1862 to the end of 1866.

The farm contains 600 acres arable and 200 pasture: the soil is a strong clay, on limestone. It is farmed on the 4-course. Thus we have 150 acres for roots, either ploughed or cultivated in autumn—in spring twice cultivated; 150 acres for wheat, after seeds, beans, and fallow, either ploughed or cultivated by steam; 150 acres for spring-corn, ploughed or cultivated. The average daily work, pl[illegible]ghing or cultivating, is calculated at 5 acres, including shifting [illegible] The number of days' working were, in 1865, [illegible]2 days; in 18[illegible] [illegible]7 days. From this it is evident that about [illegible] 180 acr[illegible] [illegible]resents the [illegible]k done, and it is equally clear tha[illegible] considera[illegible] [illegible] [illegible]illage work is still done by [illegible]

	£.	s.	d.
[illegible]	0	15	2
W[illegible]	0	3	0
Coals, 7*s.* 6*d.*, [illegible]	0	9	0
Repairs (10*l.*)	0	2	6
Wear and tear [illegible] 638*l.*, 7½ per cent. ..	0	12	0
Interest of [illegible] per cent. ..	0	8	0
	2	9	8

Assuming 80 days as the yearly average, we have an annual cost of 198*l.* 13*s.* 4*d.* Formerly 24 horses were kept to do the ordinary farmwork—now only 12 are so used; and here we may notice a fact which was constantly brought before us, viz., that the area cultivated by steam does not represent the acreage that would be worked by the horses displaced, evidently showing that by the use of steam the number of operations is greatly reduced, one thorough piece of work by steam-power proving more effective than several horse-operations. The annual cost of these 12 horses would be 600*l.*, consequently at the present time there has been an annual saving of 387*l.* 6*s.* 8*d.*

Calculating that 2000 acres have been worked by steam from 1862 to 1866 inclusive, and that the original ropes (1600 yards), costing 69*l.*, were worn out at the latter date, the expense of rope has been 8¼*d.* an acre, which agrees very closely with the most successful cases on strong land that came under our notice. The surface is generally undulating; the fields average from 15 to 16 acres, and are well adapted for steam culture—in many cases 40 to 45 acres can be worked without moving the engine. The soil is a sticky limestone-clay, difficult to work by horse labour. The effects of steam culture have been very evident in an increased produce; in the case of corn fully 6 bushels per acre, whilst root-crops are grown over a larger area and give a better yield. This satisfactory result is attributed to greater expedition attainable in catching seasons, more thorough exposure of the soil to atmospheric influence, and more perfect drainage. The clover-crops, which are grown every eight years, are greatly improved, the plant less liable to fail, and the produce increased. This is accounted for by the surface being more friable. A much heavier stock is now kept: 310 ewes are put to the ram, the lambs being sold in autumn, whilst 50 head of cattle are grazed in summer and 80 in winter. Mr. Mountstephen considers the effects of steam culture so beneficial, that he would not hesitate, if occupying the farm as tenant, to take the apparatus at a valuation. It is his opinion that 300 acres arable is the minimum area on which steam could be profitably employed, supposing that the engine is used for thrashing purposes. Last year an adjoining farm was taken in hand in a very neglected state: at the period of our visit drainage-operations were in progress, and steam will undoubtedly prove of great service in the improvements that are contemplated. We cannot leave this case without expressing our opinion of its highly successful character and importance as an instance of the profitable application of steam under good management.

No. 134. **Mr. Pacey, of Garthorpe, near Melton Mowbray,** pur-

chased in July, 1863, the 14-horse engine and apparatus, consisting of anchor, 4-furrow balance-plough, with digging-breasts, 7-tined cultivator, and 800 yards of rope, &c., with which Messrs. Fowler and Co. made such splendid work at the Worcester Show, where it will be remembered they dug up a strong clay that had been undisturbed for many years, thereby severely testing the strength of the machinery. The excellence of the plant may be further judged of by the trifling sum spent in repairs. The only expense on the engine has been caused by an accident to the pump, whilst nothing has hitherto been renewed save clips and porters—the friction-pulleys of the latter having been covered with hoop-iron riveted on, and the frame-rods strengthened by the farm-smith. Another reason for this immunity from breakage is, that at first the plough was not put in too deeply nor driven too fast. Mr. Pacey estimates the expense of repairs hitherto at less than 8*l.* a year. The farm consists of 1201 acres, 692 of which are arable. The soil is a poor strong clay, with pebbles, on a yellow subsoil, which it would be undesirable to bring too rapidly to the surface. The fields are generally large, ranging from 10 to 30 acres, some part of the arable land being hilly.

After the apparatus was put to work and found to answer, Mr. Pacey was encouraged to take another farm in a very filthy state, which he would not have occupied rent free if dependent solely on horse labour. By the aid of steam 120 acres were fallowed in the spring of 1864: some of the land being cultivated four times a complete job was made, and the land is now as clean as can be desired. It is right to state that, though only a yearly tenant, Mr. Pacey has drained all the land at his own expense 3 feet deep in the furrows.

The chief alteration in cropping consists in the growth of a larger breadth of vetches, which are eaten on the ground sufficiently early to allow of a good fallow being made for wheat. A considerable area of mangolds and swedes are produced; but the soil is too tenacious to allow of winter-feeding on the land, and the corn-crop would often be better if grown upon bare fallow. The corn-crops are decidedly increased, owing to a greater depth and finer condition of soil. Spring-corn yields fully 4 to 6 bushels more than formerly; wheat about 4 bushels: 32 horses have been reduced to 20, and the saving of 600*l.* per annum forms a handsome item for the creditor side of the account. The area worked (either dug, ploughed, or cultivated) was as follows:—In 1863 and 1864, when the work commenced, there was a great area fallowed, which accounts for the much larger result than in 1865 or 1866. In many cases the operations were repeated three or four times over, especially in 1863:—

	Cultivated.		Ploughed.
	Acres.		Acres.
In 1863–64	1250	....	33
„ 1864–65	750	....	34
„ 1865–66	286	....	97
„ 1866	175	....	70
Total ..	2461	Total	234

This represents 3½ years' work. The wet season of 1866 will sufficiently explain the insignificant amount of work, but we are at a loss to understand why on a farm of 692 acres arable, and with 150 acres of fallow and 200 acres of wheat, besides beans and barley, so little was done in 1865. According to Mr. Pacey's estimate of work per day, all that was done would not occupy 60 days. The fallow alone would represent 150 acres of ploughing and 300 of cultivation at the very least, and yet we are told that 12 horses have been put down. Our time was limited, but we walked over some of the fallows and found them very clean. Having no record of number of days during which the apparatus was used, we abstain from calculations. If 12 horses have been saved, steam has proved a great gain at Garthorpe.

No. 135. The last visit of the Committee was paid to Lord Berners, Keythorpe Hall, whose tenacious soil and undulating surface has been greatly benefited by steam; so much so, that notwithstanding much breakage and many disappointments, especially in early days, Lord Berners declares he would use steam power on an area of 250 acres arable: whereas, at Keythorpe, the farm contains 380 acres arable, and 520 in pasture. The soil is naturally a stiff binding clay resting on clay, but has been greatly improved by drainage, subsoiling, and autumn cultivation, carried on for many years. The fields are generally suitable as to size—from 10 to 25 acres each; though more or less undulating, many fences have been grubbed and fields made as square as possible. In 1861, at the Leeds Show, Fowler's sheaf-windlass was purchased to be driven by Clayton and Shuttleworth's 10-horse-power engine; but after a considerable trial abandoned, as the breakages and stoppages were so frequent that at least one-third of the time it was standing still. In 1862 an exchange was effected, Fowler supplying an upright double windlass driven from the engine by a connecting-rod. Four wheel-travelling anchors are placed on either headland, which take the place of the anchors and snatch-blocks in Howard's system. Howard's cultivator, Fowler's 3-furrow plough, and Smith and Ashby's rotating harrows; are employed, the total cost amounting to 798*l.* 15*s.* 1*d.*, as thus:—engine, 291*l.* 15*s.* 6*d.*; plough,

windlass, anchors, &c., 448*l.* 5*s.* 10*d.*; cultivator, 21*l.* 15*s.* 9*d.*; harrows, 12*l.* 18*s.*; water-cart, 24*l.* We saw the work going on in a hilly field, the engine being placed at the bottom. The gearing of the windlasses is effected by a strong spring and clutches, this arrangement caused more vibration than was desirable, and we much prefer the simpler mechanism of Howard's windlass. The ploughing was well done. We do not consider Fowler's anchors a desirable or necessary addition; they are costly, difficult to move about, and must naturally increase the time and labour of moving, whereas the claw-anchors and snatch-blocks are thrown into a cart and taken away at once. It was said that they would not hold, and were constantly dragging, but this is not general experience; and as the engine is only 10-horse power, we feel satisfied that no force which it is capable of exerting would cause the anchors to drag if carefully looked after.

Since the present plan has been adopted—5 years—the repairs have averaged about 50*l.* per annum; this sum includes 2 new ropes, bought in 1865 and 1866. Ashby's rotating harrows are highly spoken of, being attached to and following the cultivator; this is a matter of very simple arrangement,—a strong iron bar is fastened across the middle of the cultivator at right angles, 4 ft. from centre on each side, at each end is a large iron ring, to which is attached, by a sufficiently long chain, the harrows; before the cultivator turns at the end the driver or a lad pulls each harrow sufficiently aside to allow the cultivator to return without contact, the harrows settling at once in their place. Lord Berners spoke of the harrows collecting the weeds and leaving them in heaps in a manner that was highly satisfactory. The greatest advantage gained by the possession of steam-power was in 1863, when some 80 acres of miserably neglected land came into occupation, and was thoroughly kn[illegible] about and cleaned between Aug. 3 and Oct. 2. The [illegible] be gathered from the following details:—

[illegible] 3 cultivated 4 times over, 8 inches deep.
[illegible] 1[illegible] " [illegible] "
[illegible] " [illegible] 9½ "
[illegible] " [illegible] 4½ "
[illegible] " [illegible] "
[illegible] dug on[illegible] 8 inches deep.
[illegible] cultivated 1[illegible]
[illegible] team harrow[illegible]

The[illegible] beneficial, yet whe[illegible] with [illegible] labour th[illegible] work could not have been under-taken are great fac[illegible] steam culture.

[illegible] following figu[illegible] ng to certain work performed

between Feb. 23 and May 16 will be instructive, as showing the average spring work per diem :—

Ploughed.	Grubbed.	Depth.	Days.	Removals.	Coals.	Oil.	Wages.	Repairs.
Acres.	Acres.	Inches.			£. s.	£. s. d.	£. s.	£. s. d.
43	97½	6 to 8	51	17	21 12	2 15 3	37 8	5 4 6
	131							
	(Part harrowed after.)							
43	228½							

This averages nearly 5⅓ acres daily.

The daily expenses in winter are as follows :—

	£.	s.	d.
5 men	0	10	6
4 boys	0	3	5
Horse and water-cart	0	4	0
Coal, 11 cwts.	0	9	4
Oil	0	1	0
	1	8	3

In summer, 2*d*. a day extra per head.

In addition to the above, 8*d*. an acre for ploughing, and 4*d*. an acre for cultivating, is paid, which would increase the expenses about 2*s*. 6*d*. a day.* No journal has been kept of the work, but we have been furnished with the operations during the seasons of 1864 and 1865, from August 29th, 1864, to April 18th, 1865, during which interval the apparatus was working and shifting 87½ days, and ploughed or dug 200 acres, and cultivated 146 acres; which is barely 4 acres per day,—rather a poor result, attributable partly to the fields lying at considerable distances, and the hilly nature of the land. Taking this specimen as an average we can arrive at the annual cost :—

	£.	s.	d.
Labour	0	16	5
Horse and water-cart	0	4	0
Coal and oil	0	10	4
Repairs	0	11	5
†Wear and tear on 650*l*., at 7 per cent. ..	0	11	1
Interest at 5 per cent.	0	7	5
Cost per day	3	0	8

* The men employed working mowers, reapers, and other machinery, are allowed 6*d*. a day extra, which is sometimes varied by payment per acre for work done. This works satisfactorily, stimulating all the young men to become skilled labourers.—B.

† The difference between this and the original cost is a deduction in engine for thrashing work.

15*s.* 4*d.* per acre appears to be the cost of ploughing and cultivating, the proportion due to each not being ascertainable. Annual outlay for steam cultivation, 265*l.* 8*s.* 4*d.*

It is difficult to arrive at the saving in horses, the work of the estate being mixed up with the farm. It is estimated that 12 horses are put down; but, looking at the specimen of work in 1864 and 1865, this appears more by about one-third or one-half than the results justify: even if only 6 horses are put down, there has been no loss, and the effects on the crops are satisfactory.

CONCLUSIONS.

In endeavouring to arrive at conclusions, we avoid instituting comparisons as to the merits of different inventions—on this point our readers will judge for themselves—but we may point out the conditions most suitable for each. Where the farms are small, the arable land under 300 acres, the land hilly and the fields irregular, we believe the roundabout system will prove most practical and economical, whether the land be light or heavy. Where the land is level, the fields large, and we have an area sufficient to employ the machinery, say for 100 days per annum, direct traction offers advantages, in greater power and deeper work, especially in the case of strong land, provided we have roads for the engine to move on. The difficulty of travelling on soft headlands, and the delays that arise therefrom, are serious obstacles with traction-engines. On large areas of light land great results might be anticipated from the double-engine system, since there would be no trouble with the engines and no difficulty about getting forward fast enough for the use of wide implements; unfortunately our inspection did not afford any experience of double engines. Our general conclusion is, that success depends more upon management than upon the nature of the apparatus—good management will command success under adverse conditions, whereas no advantageous circumstances can compensate for want of intelligent supervision on the part of the proprietor, which should be based upon a thorough practical knowledge of steam machinery. There must be patience and determination not to be overcome by the many difficulties which novelty and ignorance give rise to. Granting, then, that the machinery is in good hands, and the conditions favourable, the resu[illegible] will be a success — varying, of course, with [illegible] this being so, we

naturally enquire how it is that steam culture has made comparatively so little progress. Want of accurate information may be one cause, deficiency of capital another, and possibly want of confidence in the security of tenure a third. And this brings us to another point, viz., the necessity for co-operation between landlord and tenant. Farms require more or less preparation for steam, fences should be taken up, and in some cases roads made. The latter work ought to be carried out by the landlord, and a fair interest paid by the tenant. Again, trees left in the arable fields present a serious obstruction, and unless landlords are prepared to assist tenants in such matters the latter may well hesitate to incur the large outlay required. In the majority of instances, we found the proprietors satisfied with results, and, having once experienced the advantages of steam over horse-power, unwilling to go back to the old system; in one instance we have the incoming tenant taking the machinery at a valuation, entirely as a matter of choice, convinced that it would pay him well to do so. This is most important testimony, and is not weakened by the fact that we have a case of an opposite nature, since the peculiar circumstances perfectly justify the action of the incoming tenant.

A point of great importance on strong land is the effect of steam cultivation on drainage and produce. With the exception of Lord Zetland's farm where extraordinary horse culture had been adopted previous to the introduction of steam, and that of Mr. Pease, where steam had not been fairly tested, the evidence is favourable on both points, and we find as the result of experience that which we already anticipated theoretically, viz., that the increased depth of surface and the absence to pressure greatly increase the absorbing powers of the soil, and consequently assist the action of the drains. So long as we trample a hard pan a few inches beneath the surface, so long must we have surface-furrows and high-backed lands, in order that the rain-water, which cannot enter, may run off rather than lie stagnant on the surface rotting plant-life. We fail of exact evidence as to increased produce because farmers, as a body, will not, and indeed cannot, carry out accurate experiments. In many cases the increase has not been sufficiently marked to be visible to the eye, whilst in others from 4 to 8 bushels per acre is the estimated increase of corn-crops, and such a result would add materially to the profits on steam.

The next point to be considered is the area on which steam can be profitably employed. We have seen one instance where good results were obtained on 138 acres, but the circumstances are too exceptional, and the general management too remarkable,

to allow of conclusions being drawn, so we think that 250 acres of strong arable land is the minimum quantity on which it would be wise to introduce steam culture, the engine still earning most of its money at other work; in such a case we decidedly recommend the roundabout plan, with a cultivator and plough. On such a farm 10 horses would be reduced to 6 or 7, and the saving of 150*l.* to 200*l.* would go a good way towards paying the expenses. On light land a larger breadth would be desirable, say from 350 to 400 acres, and as the acreage is increased beyond these limits, the profit of the investment would be increased. Wear of rope will always prove a formidable source of outlay; rather to our surprise we cannot discover any material difference in favour of direct traction in this respect; in some cases, depending probably upon difference of soil, we find the advantage the other way; the limits appear to be from 6*d.* to 9*d.* an acre. A point of great importance to impress upon the novice is not to rack and strain the engine at starting by overtaxing its powers. Many people have an idea that the power of steam is really without limit, and that the proper thing to do is to go down several inches below the horse pan, and increase the depth at one operation, whereas better results will follow more gradual proceedings, and the wearing parts of the engine be kept right. When heavy work is required we must be content with a less quantity, and take off one of the ploughs or reduce the number of tines of the grubber. The speed of the engine should be uniform and tolerably great, and the power should be master of the work.

One of the most important objects of this enquiry was to collect information relative to the success or failure of Steam-ploughing Companies, of which several have been established. We investigated the results in two cases, namely, at Whitchurch and Market Drayton; the latter, for reasons detailed in the report, may be passed over, since the failure of the apparatus is enough to account for the result; the Whitchurch Company affords an interesting case, from which we may venture to draw conclusions. It is not a success, nor is it a failure: the facts are not sufficiently encouraging to justify our recommending investment under similar conditions, nor are they of such a damaging nature as to preclude the hope of success under more favourable circumstances. The district is principally devoted to dairying, the proportion of arable land is limited, the fields irregular, and [illegible] very small. The land to be worked by steam is most [illegible]le, and the frequency of moves and the distances to be travelled are sad hindrances to progress. The management has been good, breakages not extravagant, yet during last year the

average work per day, including a large proportion of cultivation, did not exceed 5 acres. Under more favourable conditions —large fields in an arable district—we should have had a different result; and, under such circumstances, we believe Steam Cultivation Companies may work to a profit.

JOHN COLEMAN,
Escrick, near York.

JOHN THOMPSON,
Badminton, Chippenham.

JOHN HEMSLEY,
Shelton, Newark.

GEORGE TURNBULL,
Horton, Belford, Northumberland.

Mr. Turnbull was present throughout the whole inspection. Messrs. Thompson and Hemsley relieved each other.

VIII.—*Address of the President to the General Meeting, held December* 12, 1866.

THE Royal Agricultural Society not having held a Country Meeting this year, the Council have lost their customary opportunity of meeting the members of the Society, and of manifesting, by the success of their show, the vitality of the Society and the steady progress of British agriculture. I therefore take this opportunity of making a few remarks on some of the topics which possess most interest for agriculturists at the present time, in the hope that other gentlemen may join in the discussion, and give the Meeting the benefit of their experience and their opinions on those subjects. I wish first to mention that I shall only advert to those topics which possess a common interest for all our members, and shall avoid all such as may be likely to arouse feelings of antagonism and class interests. I press this point strongly, because some of these forbidden topics involve questions of great importance, and, as Chairman of the Journal Committee, I have frequently been urged to take steps to procure articles on such questions as leases, tenant right, preservation of game, &c. These and other similar questions are, no doubt, deeply interesting to both landlords and tenants, and nothing can be more reasonable than that men who have a common interest in any subjects of this nature should meet and discuss them; should, if they think fit, write pamphlets and newspaper articles, and endeavour, as much as possible, to enlist public opinion in support of their particular views; but when all is done landlord and tenant must in the future, as in the past, settle their mutual rights and privileges by individual negotiation and agreement; and in the great majority of cases such negotiations will assuredly end in land being let at its market value, such market value varying in some measure according to the security afforded to the tenant, that i[illegible] his capital on land that is not his own he [illegible] get it bac[illegible]. Whilst, however, admitting the full [illegible] I do not hesitate to state that the [illegible] are not the objects for which [illegible] those who took an active, [illegible] formation: I have been a [illegible] this, and I can safely say [illegible] to promote the improve[illegible] branches of industry known [illegible] the prosperity of both land[illegible], and in the prosecution of [illegible] pull together. I must here [illegible] that I mean to exclude from the

list of subjects properly occupying the attention of this Society such questions as the education of the agricultural classes, the best construction of labourers' cottages, and many other kindred subjects. Nothing can be farther from my intention. These subjects were set forth in our charter, and naturally and properly occupy the attention of the Society at the present moment; but improvements of all kinds, whether in education, or in farm buildings and cottages, require ample means, and I repeat, therefore, that the first great object of the formation of this Society was to increase as much as possible the amount of wealth to be extracted from the soil, leaving the apportionment of it between landlords, tenants, and labourers, to be settled between man and man at fitting time and place. Nor is the sphere of our operations thus defined either a narrow or an ignoble one. We may well be content to devote our energies to the production of the great staple products which must always form the main bulk of the food of man, and to produce this food in greater quantity and of better quality than heretofore is one of those highly gratifying results which, whilst improving the position of the agriculturist himself, adds at the same time to the comfort and wellbeing of even the humblest classes of his countrymen.

Having thus limited myself at the outset, I will first advert to that subject which has been one of absorbing interest during the whole of the past year—I mean the cattle-plague. At this time last year the Council of this Society were exerting themselves to bring the collective weight of this and other leading agricultural societies to bear in inducing the Government to adopt certain stringent regulations for preventing the movement of cattle generally, and for slaughtering promptly those attacked by the disease. The resolutions unanimously adopted by the Council with this view were, as nearly as may be, subsequently embodied in the "Cattle Diseases Prevention Act;" and, looking at the immediate check given to the cattle-plague when that Act came into force, and its subsequent rapid and continuous decline, few persons are now found to question the soundness of the policy then pursued. The cattle-plague has now for a considerable period been brought into such narrow compass that we may reasonably hope soon to see it altogether extinguished; and it seems to me important that, whilst its disastrous effects are still fresh in our memories, we should not allow our attention to be diverted from the true character and results of this calamity until such regulations be permanently adopted—be made, in fact, part of the law of the land—as may give us all the security against its recurrence which the nature of the case will admit of. The late attack of rinderpest may be said to have lasted little more than a year, for though the first cases were observed at the end of June, 1865, it had not made any great progress before August of that year, and by the end of August,

1866, the attacks of the disease had been reduced within very narrow limits. In point of duration, therefore, the great visitation of rinderpest of the last century, which lasted from June, 1744, to 1757, or thereabouts, varied materially from this. But rinderpest, like other things, travels by railway in these days, and in little more than three months from its first appearance it had invaded more than half the counties of England and a large portion of Scotland. The number of diseased animals which have died or been killed amounted on the 24th of November last, to 209,332. No return of their value can yet be obtained, but taking the average value of 1864 head slaughtered in the West Riding of Yorkshire, and applying that average to the whole number, we obtain a total of 2,690,000*l.* This, however, does not represent the whole of our loss, as a considerable number died before the passing of the Cattle Diseases Prevention Act, whose deaths were not reported to the inspectors. Heavy losses were also incurred by the forced sales and premature slaughter of young animals in store condition, in consequence of the panic caused whenever the disease made its first appearance in a new neighbourhood. On the whole I cannot rate the national loss caused by the cattle-plague at less than three millions sterling. It is mortifying to reflect that (humanly speaking) this great loss might have been in great measure prevented if we had not been too proud to profit by the experience of our own and other nations who had frequently had to battle with this terrible scourge, and who had uniformly come to the conclusion, after repeated attempts at cure, that immediate isolation and slaughter of all animals attacked by rinderpest was the only mode of escaping heavy loss. No doubt some will be found to dissent from my conviction, that this great loss might have been almost entirely prevented if our existing machinery for stamping out cattle-plague had been set to work on its first outbreak. It will be difficult, however, to escape from this conclusion if we compare the results of the "laissez-aller" and the "stamping-out" methods in the summers of 1865 and 1866. Compare, for instance, the month of July, 1865, with the month of September, 1866. In the former month there were 79 fresh outbreaks of the disease; in the latter there were 74. So that the number of new centres of infection created were in each of these months nearly the same. In the latter case, however, the stamping-out principle was applied to these new sources of infection, in the other they were left to increase and multiply. And what was the consequence? Two months [illegible] l effect of these new outbreaks would be fully seen [illegible] in September, 1865, 954 fresh outbreaks, attacking [illegible] animals; whilst in November, 1866, there were only 8 fresh outbreaks, attacking 16 animals. Why should not the 74 fresh outbreaks in September, 1866, have done as much mischief proportionately [illegible] ly, 1865? Some will say that the disease was

worn out, had become less intense or less contagious than it was a year before. This, however, is not the case, as throughout the whole of this visitation the nature and character of the attacks have been remarkably uniform, and in the very latest cases, the disease has shown itself just as contagious and just as fatal as at the first commencement.

I have already shown that we, as a nation, have incurred a very heavy loss rather than admit that our scientific means and appliances are as insufficient now to cure or even mitigate this disease as they were a century ago, in this country, or as they are in other countries up to the present day, but having paid so dearly for our experience, it would be totally inconsistent with the business-like and practical character of Englishmen if we did not take steps to profit by our past error, and to prevent our having to buy our experience over again at the same heavy cost. With this view the Council have within the last few days sought an interview with Her Majesty's Government, and stated our unanimous conviction that so far as the present attack of rinderpest is concerned, it would be highly impolitic to relax the restrictions which have proved so effective until a sufficient time shall have elapsed without the occurrence of a single case to afford a reasonable probability that the disease is extinct in Great Britain. With reference to the future, we also pointed out the importance of obtaining from Parliament, in a permanent form, the power to revive at any time when required the existing machinery. That this machinery is efficient for its purpose is proved by the fact that in any of the later outbreaks the disease has rarely extended beyond the farms where it first appeared, unless from great apathy and negligence on the part of the local authorities. If the provisions of the Cattle Diseases Prevention Act are not renewed they will expire next June, or at the end of the then session of Parliament, and on any new outbreak of the disease Parliament would have to be called together, or, if then sitting, the tedious process of passing a Bill through both Houses would have to be incurred before any effective measures could be taken, and we should assuredly have again to pay dearly for our want of foresight. The third point, which the Council consider of equal, if not greater importance, than either of the two former, is that the importation of foreign cattle should be permanently placed on a safe footing. The whole character of this trade has been changed by the continued extension of railways on the continent of Europe, occurring as it has done simultaneously with a great increase in the price of cattle in the English markets. These two causes combined make it answer to the importer to bring cattle from much greater distances, and we can no longer consider Rotterdam and Hamburgh as the ports from which only Dutch or North German stock are brought here, but they have become the termini of a great

network of railways, at the other end of which lie the great steppes of Eastern Europe, from which the rinderpest is rarely absent; and we are placed in nearly as much danger as countries like Austria and Prussia, which, geographically, lie much nearer to the sources of infection, and which have only kept themselves free from most calamitous losses since they have adopted very stringent regulations as part of their permanent code, ready to be put into active operation at the shortest possible notice. The number of store cattle imported is so limited that it would not be difficult to establish an efficient system of quarantine for them, and there can be little doubt but that if it were once thoroughly understood, that in future all fat cattle must be slaughtered at the ports of disembarkation, arrangements would soon be made by which it could conveniently be carried out, and I am sanguine enough to believe that after a time it would be conducive to the interest of the importer, as it assuredly would be to that of the consumer. Let it be assumed that convenient slaughter-houses were constructed at the ports both of export and import. In winter, when the passage is rough and tedious, and the importers suffer great losses by general deterioration and numerous deaths amongst their live cargoes, they would slaughter the cattle at Rotterdam, Antwerp, Ostend, and other convenient ports, and during the winter months the meat could be brought over in capital condition. During the summer months, when fresh meat would not bear a sea voyage, the animals must be brought over alive, but at that time of year the passage loses half its terrors, and the cattle would be slaughtered at Hull, Harwich, or the port of London. Even now fresh meat is becoming an article of daily importation, and from a return kindly furnished to me by the President of the Board of Trade, I learn that in the month of October last no less than three millions four hundred and twenty-eight thousand pounds of meat, salted and fresh, were imported, of which the greater portion was fresh mutton.

The next question to which I shall allude is what has been termed the [illegible] difficulty. All who are engaged in rural pursuits are [illegible] wages have risen very much during the last few years, [illegible] only has labour become a more costly item in farm expen-[illegible] is extremely difficult in many districts to obtain a suffi-[illegible] the right sort of men. Some years ago it was very common [illegible]o hear farmers severely blamed for not giving high enough wages [illegible] labourers, and now it is equally common to hear the labourers [illegible]t with for asking extravagantly high wages. In each case [illegible]aints are equally unreasonable. A farmer who should from [illegible] of heart give much higher wages than his neighbours would [illegible] himself in the *Gazette*, and it would be equally unbusiness-[illegible] expect that labourers should ask lower wages than they think [illegible] contributed to bring about the

present scarcity of labour in particular districts, the most influential of which have been the rapid expansion of trade, the successive alterations which have been made in the law of parochial settlement, and, above all, the great increase in the facilities and cheapness of locomotion. The change, though gradual, has been progressive, and appears likely to be permanent, and it is an interesting question how best to deal with it. A noble lord at an agricultural dinner in one of the midland counties, a few months ago, was so much impressed with the importance of the question as to suggest the possibility of applying the co-operative system to agricultural labour. Judging from the newspaper report of his lordship's speech, he did not do more than throw out the idea with the view of eliciting discussion. It does not appear to me that the labourer could fairly be allowed to participate in the farmer's profits in good seasons unless he could also bear his share of the farmer's losses in bad ones, which he would clearly be unable to do; but there is one mode in which the farmer might admit his labourers to be partners in his farm, which would, I think, go some way towards surmounting the present labour difficulty, and would, with little cost to the farmer, be of incalculable benefit to the labourer. The plan I would suggest is that the farmer should let to a certain number of his labourers sufficient grass-land to enable each of them to keep a cow, and that these allotments should be the rewards of industry and sobriety. I have for some years watched the operation of two modes of carrying this out, one plan being to let to each man a separate field of two or three acres, which is much preferred by the men; the other being to give up two fields of considerable size to a number of men, who use one in common as a summer pasture for their cows, and mow the other for hay, the separate holdings being marked out by a post at each corner. The latter method is suitable for large farms on which it might be difficult to find or to form a sufficiency of small fields for separate allotment. Both plans work well. The cost to the farmer is trifling, as the cottagers are always willing to pay a fair rent for the land. To labourers with families the advantage of keeping a cow can hardly be overrated, but I do not think it advisable to confine it to fathers of families, as a steady married man without children is thus enabled to save a little money, and becomes so much interested in his cow and his pig that the alehouse is no longer the chief source of attraction during his leisure hours. Those who are best acquainted with agricultural labourers will, I feel confident, bear me out in the assertion that a man who can ensure regular work, at fair wages, with sufficient land to keep a cow and a pig, and obtain even a moderately good cottage among the friends and neighbours whom he has known from his childhood, will seldom be found willing to exchange his

position for the crowded courts and alleys of the large towns, even by the temptation of considerably higher money wages.

The council have, during this year, devoted a good deal of time and attention to the organisation of a critical inquiry into the results of steam cultivation, followed up by an examination of selected farms in most of the counties of England. The high price of mutton and wool for several years has given such a stimulus to light-land farming, that the strong wheat lands have receded in public estimation, and are at present most in need of improvement. Yet Mr. Lawes has proved that even by the ordinary methods of cultivation, about two quarters of wheat per acre may be grown on strong land for twenty years in succession *without manure;* and Mr. Smith of Lois-Weedon, has carried this further, and shown that by a thorough disintegration of the soil, and repeated exposure of a fresh surface to the fertilising effects of the atmosphere, at least 4 quarters of wheat per acre may be calculated upon as the average produce of moderately good wheat land for an equally long period. The only drawback to this gratifying result consists in the heavy cost of cultivating the stiff clays. The steam-plough is the most likely agent to get over this difficulty, and the able men who are at present engaged in arranging the great mass of information they have collected on this subject will, we trust, be able in their reports to show us the extent to which the employment of steam machinery in the cultivation of strong land has been commercially successful, and also to point out any special causes which have retarded its introduction and diminished its beneficial effects, whether arising from the imperfections of the machinery, or from improper modes of applying it.

One of the most promising features in the agricultural prospects of the present day is the almost unlimited demand which exists for many of those products which our soil and climate are specially adapted to produce in perfection. The western counties of Great Britain and Ireland are peculiarly well fitted for the breeding and rearing of live stock, yet our constantly increasing imports show that the home supply is by no means equal to the demand. If our acute but misguided fellow-countrymen in Ireland would abandon their Fenian follies, and devote themselves heartily to the cultivation of green crops and the improvement of their pasture lands, they might appropriate a large portion of the vast sums which are now expended [illegible] bringing live stock from the most distant parts of Europe. Even now there are more cattle in Ireland than in England, 3,493,000 against 3,307,000, and that number might with ease be very largely increased. Dairy produce, too, has for some years borne a very remunerating price and need fear no competition from distant countries. The effect [illegible] cattle plague on the supply of milk to large

towns is remarkably illustrated by the quantity of milk now conveyed by railway for the supply of the metropolis. The seven great railway companies, who principally conduct this trade, have kindly furnished me with the following interesting particulars. One company says that the increase in the quantity carried in 1866 above that in 1864 is 86 per cent.; another company says their increase is 120 per cent.; a third, 352 per cent.; and the London and North-Western, and Brighton companies, state their increase at fifty and sixty fold respectively. There are now more than 220 stations sending milk to London, by passenger or special milk trains, from distances varying from 7 to 190 miles, for a charge varying from a minimum of a halfpenny to a maximum of 2*d*. per gallon for the whole distance. In the last three months, September, October, and November, 1866, which are the worst months in the year for the milk trade, no less than 1,652,000 gallons of milk have been brought into London by rail, showing that we should probably underrate the total quantity carried for the year 1866, if we stated it at 7,000,000 gallons. This is a remarkable instance of the rapidity with which so extensive a trade in an article which is difficult to move in large quantities, and which yet will not bear delay, has been transferred to new and distant localities, when circumstances required it. It is to be hoped that this large introduction of good country milk will effect some improvement in the very unsuccessful mixture which has hitherto been sold under the name of London milk.

The favourable prospects of which I have spoken are by no means confined to the western side of England. The drier climate of the eastern counties is specially adapted to the growth of first-rate barley, and the value of a little extra quality in the sample was never more plainly shown than in the present season. The landowners of the eastern counties, however, must pardon me for saying that they do not make full use of their advantages. Barley growers will all tell you that they can only grow good barley on good land, but a large portion of the light sands have marl or clay in their immediate neighbourhood, and that marled sand will grow good barley is well known and extensively acted upon by many of the leading agriculturists in that district; but there are still thousands of acres of poor weak sands with marl in their midst which, if liberally applied, would double the value of the land, and enable it to produce better barley than any yet imported from other countries. To watch for and promptly seize any opening for a profitable trade which the changing circumstances of the times may afford, and especially to turn thoroughly to account any peculiar advantages of soil, climate, or position, requires, however, not only the shrewd sagacity for which our farmers are distinguished, but also a cultivated intellect, the result of a really good

education, which, unfortunately, many of our farmers have not been able to obtain. In the endeavours which the Council have lately made to fix the attention of the agricultural world on this subject, they have naturally felt that the amount of funds which could be spared for this purpose were so small as to be utterly inadequate to provide the means of education for the most limited number of youths. They have, therefore, adopted the only course which seemed to be open to them, viz.: that of offering a few prizes of moderate amount for general competition, in the hope that this practical expression of opinion on the part of the Royal Agricultural Society would, at any rate, draw attention to the question, and might be of some value as an indication of the kind of education which is most required for young farmers, and in which they are most deficient at present.

By way of recapitulation, I wish, first, to urge strongly the importance of treating cattle-plague like a conflagration, and that it is as much a matter of ordinary prudence to keep up the machinery for stamping out the one as it is to keep fire-engines and firemen ready at a moment's notice to extinguish the other. Secondly, I hope to see the method I have suggested of dealing with our labourers generally adopted, and supplemented by others of a similar character, whereby we may give the men local interests, and the strongest possible inducement to establish a kind of savings' bank in their own pigsties and cow-houses, a step which is not unlikely to lead eventually to the savings' bank in the neighbouring town. But, at all events, this will increase the self-respect of the labourers themselves, and enable them to bring up their families in health and comfort. Thirdly, the education of the rising generation of farmers requires thoroughly overhauling and adapting to the wants of the day. This movement has already begun in one or two counties; but there are many deep-seated prejudices to be removed, and there is much *vis inertiæ* to be overcome before our middle-class education is brought up to the present high standard of English civilisation. Lastly, under the good providence of God, who has promised us a return of seed time and harvest so long as the world endures, the present prospects of English agriculture are highly encouraging. Our improved facilities of transport, both by sea and land, are continually giving us access to whole nations of new customers, and as long as our foreign trade continues to increase, so long will the consumption of home-grown commodities by our labourers and artizans be such as to provide a remunerating demand for all the beef and the beer, the milk, butter, and chee[illegible] [illegible] combined practice and science of our farmers

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PRACTICE WITH SCIENCE.

LONDON
JOHN MURRAY, ALBEMARLE STR
1867.

These experiments, it is true, are not easy; still they are in the power of every thinking husbandman. He who accomplishes but one, of however limited application, and takes care to report it faithfully, advances the science, and, consequently, the practice of agriculture, and acquires thereby a right to the gratitude of his fellows, and of those who come after. To make many such is beyond the power of most individuals, and cannot be expected. The first care of all societies formed for the improvement of our science should be to prepare the forms of such experiments, and to distribute the execution of these among their members.

Von Thaer, *Principles of Agriculture.*

London: Printed by William Clowes and Sons, Duke Street, Stamford Street, and Charing Cross.

GEOLOGICAL MAP OF WORCESTERSHIRE.

IX.—*The Agriculture of Worcestershire.* By Clement Cadle.

Prize Essay.

Numerous subjects present themselves for consideration in making a report on the farming of Worcestershire. There is perhaps no county in England more varied in its produce and its soil. Hops, apples, pears, and plums are added to the usual crops, and the soil ranges from the stiffest clay to the sharpest sand. Farming, too, differs widely; and I have there seen some of the best, and certainly much of the worst, in my experience.

The Geology of the County.

The nature and arrangements of the rocks in Worcestershire have had an important influence on its farming. We find in close proximity some of the best and the worst land, the desirable physical and chemical combinations for agricultural purposes being obtained by a mingling of the various formations.

The principal strata cropping out in the county, as taken in descending order, are the

Post Tertiary,
Liassic,
Triassic,
Carboniferous,
Devonian,
Silurian, and
Primary.

The Post Tertiary comprises the northern drifts and alluvium, the latter of which, being the *débris* of several formations, are generally most valuable to the agriculturist.

The alluvial deposits by the river sides often produce very prime meadow, as on the banks of the Severn and Avon, where the stream runs sluggishly. In these places clay is deposited by each flood in sufficient quantity to mix with and improve the coarser sand, thus forming a combination suitable to the growth of the finer grasses, which is rarely found on or near the banks of rapid rivers.

The Liassic embraces the inferior oolite and lias; the former, in the neighbourhood of Broadway Hill, Brendon Hill, and the detached portion of the county near Blockley, being good healthy land for sheep, but without much more agricultural merit.

The Lias comprises one of the most important districts in the county. It runs north-east from Tewkesbury to Cleave Prior,

and north-west from Broadway to Oddingley, including Bredon, Pershore, and Evesham, altogether about one-fourth of the county. Of this upwards of 1400 acres is very profitably cultivated as market gardens, growing plums, &c., in large quantities, while some of the remainder is stiff, unimprovable, and almost worthless clay.

Rather more than half the county is of the Triassic, or new red sandstone formation, the Keupar sandstone and new red marls running through the middle of it in a north-easterly direction, and comprising chiefly the districts of Worcester, Droitwich, Redditch, and Upton-upon-Severn, where valuable land abounds, especially in the neighbourhood of Kempsey and Ombersley. This district produces apples, pears, and hops.

The districts of Bromsgrove, Stourport, and Kidderminster are of the waterstone subdivision, or the upper soft red. Some portions are first-class sheep land, and in a high state of cultivation, while others are very light. In the neighbourhood of Kidderminster it is a "blowing sand," covered for many acres with gorse. These sands are of the modern marine deposits, and are derived from the Straits which once separated England and Wales.

The Carboniferous system comprises the coal and mountain limestone in the neighbourhood of Dudley, Bewdley, Pensax, and Rock. This is a poor soil and of little agricultural value.

The Devonian, or old red sandstone, is found on the extreme north-west of the county, at Tenbury and its districts, where very large oak and larch and good hops are grown, and excellent cider made. Fine herds of Hereford cattle may here be seen.

The Silurian comprises the Wenlock series, and is an unimportant formation only cropping out in the neighbourhood of Malvern, Whitley, and a few other places. The same remark applies to the Sienites of the primary formation, which are principally found in the neighbourhood of Malvern.

The Climate.

The climate of Worcestershire is, from its moisture, favourable to the growth of roots, yet the rainfall does not hinder the perfect ripening of wheat; it thus combines the advantages both of the Western and Eastern Counties, producing, where the soil is suitable, both roots and grain of first-class quality.

Mr. Thomas Henry Davis of Orleton, near Worcester, who has kept an accurate register of the rainfall for the last 30 years, has favoured me with the results of his labours as follows:—

AVERAGE RAINFALL at ORLETON, WORCESTERSHIRE, for 30 Years, 1831 and 1860 inclusive; and MONTHLY RAINFALL, 1861 and 1865 inclusive.

Months.	Average of 20 Years. 1831—1850.	Average of 10 Years. 1851—1860.	Average of 30 Years. 1831—1860.	Monthly Rainfall in 1861.	1862.	1863.	1864.	1865.
January ..	2·198	2·599	2·399	1·030	3·335	3·475	1·310	2·580
February ..	2·213	1·275	1·744	3·055	0·660	0·825	1·730	2·655
March ..	1·918	1·700	1·809	3·550	4·160	1·105	2·510	1·130
April	2·057	2·087	2·072	1·070	3·170	1·210	1·380	1·100
May	1·826	2·044	1·935	1·325	4·540	0·915	1·780	3·565
June	2·410	3·377	2·893	3·015	2·295	4·660	1·860	2·050
July	2·391	2·735	2·563	6·690	2·240	0·855	0·825	2·680
August ..	2·701	3·401	3·051	1·050	2·270	2·570	0·790	4·800
September	2·415	2·605	2·510	2·595	4·215	3·970	2·685	0·105
October ..	2·804	3·358	3·081	1·720	4·145	4·095	2·230	4·835
November	3·169	2·371	2·771	2·745	1·205	2·515	2·355	2·980
December ..	2·174	2·491	2·332	1·965	2·075	1·475	2·330	1·400
Totals ..	28·276	30·043	29·160	29·810	34·310	27·670	21·785	29·880

The above figures represent inches and decimal parts of an inch. The height of the gauge is about 200 feet above the sea-level, and 9 inches above the grass-plot on which it stands.

Average Temperature at Orleton, Worcestershire, at 9 a.m.

Months.	1861.	1862.	1863.	1864.	1865.
	°	°	°	°	°
January	31·80	37·93	39·41	34·06	33·31
February	39·85	40·49	41·43	35·63	35·04
March	44·13	41·80	43·44	40·39	37·85
April	45·37	48·92	49·74	49·14	52·35
May..	54·04	55·77	54·21	57·24	55·94
June	60·75	57·56	58·75	58·87	63·90
July	61·30	59·83	62·01	62·16	64·21
August	63·26	59·97	62·11	60·43	60·50
September	56·55	55·45	55·08	57·31	61·79
October	53·36	51·58	50·80	50·72	50·12
November	38·81	35·65	45·52	40·87	42·85
December	37·76	42·54	48·15	36·53	41·50
Totals	586·98	587·49	605·65	583·35	599·36
Yearly average	48·92	48·96	50·47	48·61	49·95

The thermometers were all made by Casella, of Hatton Garden, London, and tested at the Kew Observatory, they are placed in a stand doubly louvre-boarded, and free from the influence of buildings.

It will be seen by the above table that, except in the year 1862, the months of July and August reached the temperature of 60° in the shade, which is considered the requisite point for wheat to ripen to perfection.

Older Records.

There are not many records of the farming of the county. Perhaps the most interesting to agriculturists is in Dr. Nash's 'History of Worcestershire,' published in 1781, as showing that even at that time some people entertained enlightened views on many agricultural matters, but more especially on the improvement of grass land. Dr. Nash states: "The grass is managed better than the ploughed land, for the good farmer levels, drains, and dungs it, and finds by experience that manure pays better on grass than tillage. The uplands should not be mown more than once in three years, and should be manured when mown, as soon as the hay is carried." This advice, if given at the present day, would accord with the dictates of science and experience.

Speaking of turnips, &c., Dr. Nash recommends their growth for feeding cattle and sheep on the greensward, and says that, if managed in that way, they will keep twice as much stock. With reference to stall-feeding he says, "The cattle are fed in stalls where the ground is very wet, with turnips, grain, and *oilcake*;" and further, that the dairyman finds no inconvenience from

giving his milking-cows some turnips; but they should not be fed exclusively on either tops or bottoms—if they are, the flavour of the butter may be affected. He also accounts for there being few breeders of stock in the county by saying that the land is too good for breeding purposes.

Some statistics of hops and inclosures are given; and in speaking of the rent of the land Dr. Nash states: "The general rent of the pasture land is under 20*s.*, and the Severn, Avon, and Teme under 30*s.*, at which some of them were valued at the time of Queen Elizabeth; for in that day all the cattle, sheep, &c., had to be wintered in the vale, whereas they now grow crops on which to winter them on the hills."

The rent of the arable land is not mentioned; but Dr. Nash states, that let the land be ever so rich, the farmer generally takes two crops and a fallow, and never attempts more than three.

He estimates the area of the county at 618,240 acres, and their value at 10*s.* per acre.

In good years two or three tons of cherries were often sold before five o'clock on Saturday morning, large quantities being sent to Yorkshire and the manufacturing districts.

In writing upon the cultivation of hops, he condemns it as injurious to both landlord and tenant; as a few acres of hops swallow up the manure of a whole farm, oblige the landlord to give long credit for rent, and give the tenant a turn for gaming and traffic which frequently proves his ruin; hops, he adds, were supposed to be introduced in the time of Henry VIII., and before that were imported from Flanders. He also quotes from the Earl of Northumberland's Household Book, "that in the year 1556 the family used for brewing 256 lbs. of hoppys, and that they cost 13*s.* 4*d.* per hundred."

Mr. Noake, in his 'Notes and Queries of Worcestershire,' published in 1856, gives some interesting information. He states (page 98): "That the authorities of Broadway petitioned in the seventeenth century to have the servants' wages rated according to statute," which he gives in full:—

	£.	s.	d.	
A bailiff receiving	4	0	0	
An ordinary husbandman	2	10	0	
A maidservant by the year	1	10	0	
A labourer, without meat and drink, per day ..	0	0	7	in winter.
„ with meat and drink, per day	0	0	3	in winter.
„ without meat and drink, per day ..	0	0	8	in summer.
„ with meat and drink, per day	0	0	4	in summer.
Mason and carpenter	0	1	0	
If with meat and drink	0	0	6	

He also states that the Worcestershire magistrates, when the plague amongst cattle broke out in 1747, ordered 4*s.* per week to

be paid at those turnpikes where it was thought necessary for a person to sit up at night and watch, that no horned stock passed through without showing proper certificates, with some other interesting facts about the cattle-plague, showing that when the authorities relaxed their vigilance it broke out afresh. In speaking of the old customs, he says it was customary for the farmers to finish wheat-sowing by Allontide eve (Allhallows, November 1st), and further mentions the saying—

At Michaelmas fair (2nd Oct.)
The wheat should cover a hare.

Area and Population.

Worcestershire is bounded on the north by the manufacturing districts of Staffordshire, on the north-east and east by Warwickshire, with its important manufacturing towns of Birmingham and Coventry; on the south-east and south by Gloucestershire with its sheep, dairies, and ports; on the west by Herefordshire, with its cattle, cider, hops, and timber, and on the north-west by Shropshire, with its sheep, cattle, and timber.

It will thus be seen that many valuable commodities have to pass through the county to and from the manufacturing districts.

Its area is, according to 'Kelly's Directory,' about 780 square miles, or 459,710 acres; while Dr. Nash, in his 'History of Worcestershire,' published in 1781, estimates it at 618,240 acres, at 10*s*. per acre.

The acreage assessed to the county rate in 1865 is 455,013 acres, and the amount 1,146,266*l.*; but this does not include the boroughs, and is, therefore, an approximation only. The gross estimated rental of property assessed for the poor-rate is about 1,457,196*l.*, and the rateable value about 1,262,131*l.*

The population, according to 'Kelly and Co's. Directory' was, in 1831, 222,655; in 1841, 248,460; in 1851, 276,926; and in 1861, 307,397. Of these the mines employ 2000 persons; hardware, 8000, of which 6000 are engaged in making nails, the rest needles, &c.; iron and steel, 1200; glass, 400; porcelain, 500; brick-making, 400; glove-making, 2000; carpets, 1500; woollen, lace, ribbon, &c., 2000; and all these manufactories have great influence on the agriculture of the county, more especially on the garden produce.

It has navigable rivers, the Severn, the Avon, and the Stour.

The Stour, which is converted into a canal, forms the connecting link between its agricultural districts and the manufacturing districts of Staffordshire. The Birmingham and Worcester Canal, the Kington Canal, and that to Droitwich, all afford facilities for the conveyance of agricultural produce. Water conveyance has, however, to a great extent been superseded by

the railways, with which the county is well furnished. The Midland Railway runs all through the centre of the county, and has thirteen stations within the limits; the Oxford, Worcester, and Wolverhampton has eleven stations; the Worcester and Hereford six stations; the Tewkesbury and Malvern four stations; the Ashchurch and Evesham two; and the Severn Valley, Bewdley, and Tenbury six stations. Some of the stations are counted on two lines of railway. Thus the greater portion of the county has access to a railway within five or six miles, the value of much of the land being thereby increased by 10*l.* to 12*l.* per acre; yet too many landowners, who would have done well to give the land for such a purpose, have met such enterprises with apathy, if not with active opposition.

Live Stock.

In the recent census the cattle in the county is thus enumerated—cows, 20,818; cattle under two years, 12,565; two years and upwards, 12,406; total cattle, 45,789. Worcestershire cannot be considered a breeding county, a large quantity of both cattle and sheep being brought into it for feeding and dairy purposes. The cattle may be divided into three classes, shorthorns, Herefords, and dairy cows. The shorthorn is not bred so extensively here as he should be, particularly in arable districts, for in my belief nothing will beat him for high feeding in the yards and on prepared food; a great improvement has, however, taken place of late, and many very valuable herds are now in course of formation. Perhaps the greatest improvement hitherto effected is from the use of a good shorthorn bull with the old dairy cows.

Whilst the shorthorn gradually gains ground in arable districts, the Hereford becomes more highly valued amongst graziers, being well adapted by his short legs and compact growth to get his own living by grazing, with less inconvenience to himself than the longer-legged shorthorn. Among the principal shorthorn breeders are Lord Beauchamp; Mr. Randell, of Chadbury, near Evesham; Mr. William Woodward, of Bredon, near Tewkesbury; Mr. Jos. Woodward, Birlingham; Mr. Guilding, of Brickbarns, near Malvern; Mr. Harris, of Stony Lane, near Bromsgrove; Mr. Curtler, Claines, Worcester; Mr. Wm. Willett, Bishampton; Mr. James Webb, Fladbury; and Mr. F. Munn, Temple Langhern. The Herefords are the prevailing breed in the north-west, and are more or less distributed over the county, but there is room for great improvement in them. The principal breeders are Mr. H. Chattock, Solihull, near Birmingham; Mr. E. J. Goldingham, Grimley, near Worcester; Mr. S. C. Good, Aston Court, near Tenbury; Mr. Walker, Knightwick;

Mr. J. Prosser, Honeybourne Grounds; Mr. Griffiths, Broadway; Mr. J. H. Whitehouse, Ipsley Court, near Redditch; Mr. C. Wickstead, Shakenhurst, near Bewdley; Mr. B. Hall, Malvern Wells; Mr. John Bullock, Guarlford Court, near Malvern; and Mr. J. Smith, Shelsley Walsh, near Worcester; the latter of whom is said to have one of the oldest herds of Herefords extant, noted for their mottled faces. Many parts of the county are famous for the butter and cheese produced. Mr. Ellis, of Longdon, has taken eight or ten prizes for cheese at the agricultural exhibitions in Worcestershire, and in Gloucestershire likewise—no slight distinction for a Worcestershire man. The increasing population of the county will be sure to keep up the price of cheese, butter, and milk, and it therefore behoves every farmer to increase to the utmost this class of produce. Each dairy cow takes about three acres to keep her well all the year round. Great improvements may be made in the manufacture of cheese by studying the scientific principles which regulate the separation of the curd, on which much valuable information may be obtained from Dr. Voelcker's researches. One of the common evils, no doubt, consists in pressing the curd into the vats before it is cold, thereby inducing a species of fermentation, exemplified in its heaving. This accounts for the length of time allowed in Cheshire, Somersetshire, and other cheese-producing counties.

SHEEP.

Much of the lighter soils is peculiarly adapted for sheep, of which a large number are kept; in other parts there are but few, and these are kept upon the meadows, being fed during the winter upon hay and roots; other farmers winter them in the yards, which in some places answers very well, especially where burnt soil is used for the sheep to tread upon, as the straw in wet weather softens the horns of sheep's feet, and induces foot-rot. This may be avoided by good management, as by putting boards for them to stand upon to feed, and supplying a small quantity of fresh straw every day. The system of using burnt soil for fattening sheep in yards is largely adopted by Mr. Randell, of Chadbury: by continually turning the burnt soil it is kept fresh for the sheep's feet, and absorbs their manure, making a very valuable compost for the land. The number of sheep kept in the county, according to the last census, is—under one year, 50,379; one year and upwards, 153,775; total 204,154.

The Cotswold sheep appear to be making way upon the sands; the Leicester is however the most important of the district breeds; the Shropshire downs are also kept; but by far the greater number are cross-breds of every variety. The principal ram breeders are

—Mr. Watkins, Ombersley, near Droitwich; Mr. Harris, Stony Lane, near Bromsgrove; Mr. Randell, Chadbury, near Evesham; Mr. W. Willetts, Bishampton, near Pershore; Mr. Partington, Rouse Lench; Mr. John Dale, steward to R. Berkley, Esq., near Spetchley; Mr. Walker, of Malvern, with a few others. The high prices of wool and mutton, of late years, have given a great impetus to the breeding of sheep, and most valuable stock they are when at nine months old they can be made to realise 65*s*.

The scarcity of keep during the winter of 1864 and 1865, consequent on the dry summers, led to great improvements in the management of sheep both in winter and summer; an admixture of straw-chaff and corn with turnips, 80 or 90 per cent. of which is water, made the keep go farther, and did away with the waste of food expended in raising the cold water of the turnips to the heat of the body. Much more might be done in keeping sheep on the clay farms of this county by consuming the roots on the meadow-land, folding the sheep upon it in the same way as the light-land farmer would on his arable land, giving them a fresh pen every day; and if roots are planted early and got off the land in September, a large breadth may be grown. The only objection is that it is robbing the arable land, but this will right itself by the increased crops of hay produced, which will swell the manure heap in return.

Mr. Crowther, of the Hoo Farm, near Kidderminster, has paid great attention to the management of sheep. He farms 600 or 700 acres of land, nearly all arable, and keeps a large number of sheep; to these he gives food in pens, winter and summer, cutting the turnips in the winter and penning the sheep on the rye, clover, and rye-grass in the summer. This system he finds answer better than the old plan, in fact he follows out the Wiltshire system of folding sheep.

A gentleman near Stourport also informs me that he grows (in addition to a large quantity of roots for winter consumption) 400 to 500 tons of mangolds, storing them in long trenches about 2 feet deep in the ground and 12 feet wide, heaping them to a ridge and covering with a very thick thatch. These are generally thrown uncut to the sheep on the grass lands and seeds from April to July.

He further remarks, "I am always condemning Italian rye-grass, and always planting it." He plants red clover only every eighth year, when he generally gets a fair crop.

Horses.

During the last ten or fifteen years great improvement has been effected in the farm horses; on the whole they were quite

up to the average of other counties. It is a great drawback to heavy land farms that so many horses must be kept to work the land in proper season, eating the food which would be more profitably consumed by cattle or sheep. For this reason the wet-land farmer may with advantage rear young horses, and sell them off as they attain six years old.

Pigs.

The pigs have also undergone great improvement: compact well-grown pigs, that keep themselves in good condition, taking the place of the old raw-backed hogs, which had to be kept to be two years old before being fed out; but there is nothing special to report on them that I am aware of.

Pasture Land.

Dr. Nash, three-quarters of a century ago, mentions that the farmer found it pay him better to put his muck on the pasture than on the tillage, and to this view we shall again no doubt return. Meat, butter, and cheese will no doubt always maintain a paying price, and much of the meadow in the county being dairy and feeding land, it will gradually work itself right, for if, by dressing, two tons of hay can be grown instead of one, it necessarily follows that two beasts may be kept instead of one.

Very much of the upland meadow is of inferior quality, and in many instances it is being converted into tillage, though this does not well suit the present time. It does not seem to answer well to lay land down to permanent pasture on some of the heavier soils, for after the artificial grasses die out, it takes years to get anything like a good turf. Perhaps one of the reasons of failure is that the work is not properly done.

The meadows liable to be flooded, on the other hand, are generally very good, especially those lying near the River Avon. Drainage on meadow land is only required for the removal of stagnant water, and sometimes harm is done by over draining. I think the deeper meadow land is drained the better, provided the drains draw, but after this has been effected many of the coarser and water grasses will be destroyed; therefore it is necessary to give an ample seeding of permanent grass seeds, combined with a good dressing of bone or grass manure, not merely to supply every year a small quantity for the use of the then growing plant, but a liberal dressing of say half-a-ton per acre. This will so induce the growth of the fresh grasses and clover that another dressing will not be required for ten or twelve years. Lime may also be used with advantage on the Old and New Red Sandstone formations.

The rental of the meadow land varies from 20*s*. to 100*s*.

per acre, but there is not much let at the latter price, except as accommodation land.

It is very unfortunate that so much of the land was laid to grass in ridges in this county, as this is a source of the greatest annoyance to the farmer of the present day, who wants to avail himself of mowing and haymaking machines, and horse-rakes, without which (at least the two last) a large quantity of hay can hardly be made in this day of scarcity of manual labour; great loss is annually sustained in this county from this cause, for I have observed that much of the hay, from want of more frequent moving, has been sunburnt and turned brown, having lost its valuable juices from too great exposure to the sun, in fact I am inclined to think that sun spoils more hay than the rain.

As an illustration of the effect of the scarcity of labour, an amusing incident, to those not personally interested, occurred last summer on the borders, in an adjoining county, where mowers were so scarce that they not only had 5*s.* per acre for mowing, but insisted on being conveyed in a fly to their work.

Messrs. Wheeler and Son, of Gloucester, who have devoted much attention to grasses, and have published a list of those suitable for each geological formation, give me the following as best adapted for renovating the old pastures of the Lias and New Red Sandstone.

TABLE 1.

TABLE of Grasses to be used on the Upper Lias, Lower Lias, and Marlstone, for renovating Old Pastures.

	On Light Soils.		On Medium Soils.		On Heavy Soils.	
	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.
Perennial Cow-grass (Trifolium pratense perenne)	2	0	2	8	2	8
Perennial White Clover (Trifolium repens)	2	8	3	0	3	0
Red Clover (Trifolium pratense)	1	0	1	0	2	0
Yellow Trefoil (Medicago lupulina)	3	0	3	0	3	0
Lucerne (Medicago sativum)	0	8	0	8	0	8
Yarrow (Achillea millefolia)	0	8	0	4	0	4
Sheep's Parsley (Petroselinum sativum) ..	1	8	1	0	1	0
Smooth Meadow-grass (Poa pratensis) ..	1	0	1	8	2	0
Wood Meadow-grass (Poa nemoralis)	1	0	1	0	1	8
Timothy (Phleum pratense)	..		2	0	3	0
Evergreen Rye (Lolium sempervirens) ..	0	8	7	0	7	0
Pacey's Perennial Rye (Lolium Paceyanum)	3	8	4	0	4	0
Meadow Foxtail (Alopecurus pratensis) ..	1	8	2	0	2	8
Golden Oat-grass (Avena flavescens)	2	0	1	0	..	
Meadow Fescue (Festuca pratensis)	2	0	1	8	1	8
Various-leaved Fescue (Festuca heterophylla	2	0	1	8	1	8
Sweet Vernal (Anthoxanthum odoratum) ..	1	0	1	0	1	4

To be used in proportion of 10 lbs. per acre.

TABLE 2.

TABLE of Grasses to be used on New Red Sandstone for renovating Old Pastures.

	On Light Soils.	On Medium Soils.	On Heavy Soils.
	lbs. ozs.	lbs. ozs.	lbs. ozs.
Sweet Vernal (Anthoxanthum odoratum) ..	1 8	1 0	1 0
Meadow Foxtail (Alopecurus pratensis) ..	1 0	1 12	2 0
Timothy (Phleum pratense)	..	1 0	2 0
Smooth Meadow-grass (Poa pratensis) ..	2 8	1 8	2 0
Rough Meadow-grass (Poa trivialis)	..	1 8	..
Cocksfoot (Dactylis glomerata)	..	2 0	3 0
Meadow Fescue (Festuca pratensis)	3 0	1 12	1 8
Hard Fescue (Festuca duriuscula)	3 0	1 12	2 0
Sheep's Parsley (Petroselinum sativum) ..	1 8	1 0	0 8
Perennial Rye (Lolium perenne)	8 0	7 8	7 0
Pacey's Rye (Lolium Paceyanum)	4 8	4 0	5 0
Alsike (Trifolium hybridum)	1 8	1 0	1 8
Perennial Cow-grass (Trifolium pratense perenne)	4 0	3 8	4 0
White Clover (Trifolium repens)	3 0	4 0	4 0
Yellow Trefoil (Medicago lupulina)	2 0	1 0	2 0
Lucerne (Medicago sativa)	1 0	0 8	0 8
Birdsfoot Trefoil (Lotus corniculatus) ..	0 8	0 4	0 4
Yarrow (Achillea millifolia)	0 12	0 8	..

To be used in proportion of 12 lbs. per acre.

ARABLE LAND, ROTATION, AND CROPS.

This is rather a difficult subject to treat, as the land and systems are so intermixed that most farmers have systems of their own, more especially on the heavy soils, but on the lighter sheep lands, which are not so dependent on the seasons, more regularity is observed. A good deal of land lies in the high ridge, but deep drainage has led to a lowering of the ridge. At all events I have never seen what I have heard of as a boy, lands so round and horses so small that ploughmen could pass each other on either side the ridge without being aware of it. On the light soils they try to get rid of as many furrows as possible; indeed one gentleman told me that he calculated every furrow he made lost him half a bushel of wheat.

Messrs. Webb and Wintle, the drainage engineers at Evesham, inform me that in some instances on the heavy land (Lias) there has been an increase of 50 per cent. in the crop after draining. These lands should be broken up in autumn with the steam cultivator. The common estimate is that the cost of drainage upon the blue Lias clay is repaid in three years. The proportion of

the county drained is about two-thirds, but probably only one-third is done properly, about half of this being under loan and Government inspection.

The favourite depth where the high-backed ridges exist is 3½ feet in the furrows, using 2-inch pipes; but of course, where the lands are level a greater depth is attained.

The light land is principally farmed on the four-course system, with the exception of sometimes taking wheat a second time instead of barley.

Other farmers, who have their land clean and in good condition, adopt the five-course shift, or take turnips, wheat, barley, clover, wheat. This is a very satisfactory course, for, where high farming is followed combined with chaff-cutting and pulping, sufficient straw is not grown on the four-course system unless sheep are the principal stock kept.

In the neighbourhood of Kidderminster, a portion of the turnip crop is sometimes displaced by potatoes, the growth of which is highly remunerative even for stock.

I have been much surprised that more attention is not given to the growth of cabbage. With the exception of a few leading farmers, this plant is not cultivated to any extent in the county; the largest field (about 20 acres) I have seen was Mr. Randell's, it was all planted with cabbage, besides some other portions of the farm. The scarcity of keep within the last two seasons has led to great increase in the growth of this plant, especially the early sorts, such as the Enfield, which should be planted in October that they may be ready for cutting in the following summer; they are then very valuable for lambs and young stock, the sprouts yielding a second crop for folding on in September.

On much of the heavy land the old fallowing system is still followed, after which wheat is planted, then beans, peas, Lent-grain, or clover; then wheat, followed by fallow again. Others put half roots and half naked fallow, so as to fallow once in eight years; but I am convinced that on the heaviest land the naked fallow may be dispensed with by autumn cultivation, early planting of roots on the ridge, a free use of the grubber horse-hoe, and the removal of the roots in September, so that wheat may be planted before the 20th of October.

On some farms the rotation has been to a great extent modified by the amelioration that has taken place in the land by clay-burning. This is especially valuable upon the Lias, both physically and chemically.

Mr. Randell, in 1844, thus described it in Vol. v., p. 118, of this Journal:—"The proper mode is to move the soil with a pick-axe, breaking it all the time as much as possible; it is

then put lightly upon the fires with a shovel." The expense is from 3*l.* to 4*l.* per acre, as follows—200 yards in a heap:—

	£.	s.	d.
100 yards per acre, labour to burning, at 6*d.*	2	10	0
2 tons coal (slack), at 9*s.*	0	18	0
Wheeling and spreading a distance of 50 yards from the heap, and filling and spreading the remainder, 100 yards at 1½*d.*	0	12	6
Total	£4	0	6

By these means he doubled the crops formerly grown. In 1863 he writes further (Vol. xxiv., p. 540):—"Twenty-two years' experience of the effects of burning clay-land have confirmed my first impression of the benefit to be derived from it; and I may say with confidence that on such soils, apart from draining, I know of nothing by which so much good can be effected." He adds that he prefers wood faggots to coal, not only as being more economical, but because the soil is not burned so hard; he also finds a greatly-increased quantity of sheep can thus be kept on the land.

He also gives the following as a desirable system of rotation after the land has been so burnt:—

1st year: Wheat.

2nd: Half clover (mown), half mixed seeds (grazed).

3rd: Wheat.

4th: Half beans, half fallow crops, reversing the root and bean crops every four years.

Some of the best farmers in the neighbourhood of Evesham, where the land is good and drained, grow a crop of Nonpareil cabbage, part of which is sold at market and the rest eaten off by lambs by the beginning of June. The land is then planted with turnips, of which a heavy crop is obtained and eaten off by the middle of November, and a good plant of wheat is obtained by the middle of December.

Several other variations in the rotations might be named, but they are known to most farmers, and such statements are difficult to follow; suffice it to say, that from the high price of meat, the growth of roots, especially mangolds, is gradually increasing on the heavier soils.

This county produces very fine wheat, some of which has weighed 68 lbs. to the imperial bushel. This crop requires to be planted very early on the heavy land. Barley is not generally grown, but some of very fine malting quality is produced on the medium soils.

An eminent brewer informs me that the best districts for barley are those of Bredon, Eckington, Severn Stoke, Ripple, Kempsey, Pershore, Wick, near Pershore, Hallow, Hanby, and

along under the range of the Malvern Hills on this side of the county, and that he bought one sample in 1864, and one in 1865, that weighed 61 lbs. per bushel.

Beans, peas, &c., are largely grown, much of the heavy land being peculiarly suited for the former crop. Vetches are generally grown for the horses, whilst some heavy-land farmers grow them also for soiling purposes. Clover is the most valuable crop the stock farmer can grow, and a large quantity is sown, but of late years it has lost stock to such an extent that it is being replaced by Italian rye-grass.

Our cleverest men are apparently undecided whether this is due to want of potash or not. This I know, that where croppings of hedges have been burnt, the clover generally grows very luxuriantly. Italian rye-grass is a very valuable crop on light land and on medium soils which are drained; I have met with some splendid fields in the neighbourhood of Kidderminster, Bishampton, Pershore, and Rouse Lench; also near Stourport. It is very important to secure imported seed.

Root crops have made wonderful progress during the past twenty years, and this is attributable in great measure to the introduction of artificial manures. Many of the crops of mangolds grown in the county are very heavy; indeed it is in places the most profitable crop grown. Root culture is the basis of all good farming, more especially if they are grown on the ridge, and the grubber horse-hoe used all through the summer. I have myself used it until the middle of September, and it is a first-rate preventive of mildew, which, like all blight, does not attack a healthy plant, but those which come to a stand-still in growth, as is often the case with swedes when the land gets set firm between the rows, thus preventing the passage of air and moisture to the roots of the plants.

Farm Buildings.

These are below the general average of other counties; they are principally covered with Brosley-tiles, but too often with thatch or stone tiles; many of the old buildings are very badly arranged, often having the house on the north or east side, and the buildings so placed for the cattle to be in sight from the windows, that the yards, sheds, &c., are exposed to all the cold winds. This arrangement may to some extent be accounted for by the outfall of the county being on the south side; therefore much of the land faces the south too; and in erecting buildings without studying the requirements of stock, the house gets placed on the upper side—the north—with the buildings below it. This want of convenient and warm buildings—not necessarily fine-looking

and expensive structures—is a serious drawback to good farming. The two principal points to be attended to are economy of labour in attending the stock, and economy of warmth. To meet the first requirement, there should be such a disposition of the various departments that the straw and food should go in at one side and pass continuously on until they go out at the other as manure, with no carrying to and fro, especially of so bulky an article as straw.

The labour of one man saved for an hour per day during the six months when the stock are mostly at the homestead, represents something like 60*l.* worth of buildings. As to economy of warmth, I venture to think that the same food that would keep four beasts in open foldyards exposed to cold winds would keep five in a well-protected yard with plenty of good sheds.

I have seen such gross violation of these rules that I have been tempted to note them; on the other hand, I have seen many very good homesteads replete with every convenience.

The best conversion of inconvenient into suitable buildings I have met with was made by Mr. Randell at Chadbury. Amongst other improvements, he has erected a steam-engine, and converted the old circular shed formerly used as a horse-walk into a chaff-room: there is a loft over this, with an opening to the straw-barn; in this loft the chaff is cut, and falls on to a riddle which sorts it into different lengths to suit the stock, each length falling into a different compartment at the centre of the old horse-walk: into these compartments a pipe conveys the waste steam from the engine, so that if the chaff is not quite sweet it can be rendered so, and can also be steamed regularly if preferred in that state.

The farms being generally small, the erection of fixed steam-engines does not make much progress. On those farms where straw is very deficient it may be desirable that the cattle should be fed out in the yard instead of in the sheds, they have then dry beds in the sheds to go to and lie down upon after filling themselves.

A great deal of unnecessary expense is often incurred in the erection of farm-buildings; where the work is to be done with borrowed capital, the expense often deters the tenant from entertaining the question. In such cases the tenant should be called upon to pay 5 per cent., the landlord undertaking the rest of the charge for a loan; these terms would often lead to the work being more economically executed. Good sheds for the stock are the principal requirement; one good barn is sufficient; and, where there are several, they should be converted to other uses, the making of beef and mutton being the grand objects to be kept in view. Upon sheep-land there are often far too many buildings.

Farm Implements.

In Worcestershire less improvement has been made in farm implements than in many other counties. We still find the old wooden plough, harrows, &c., in use, whilst many farmers have not even risen to the horse-rake. Still, these are exceptional cases, for scarcity of labour affects this, in common with other parts of the kingdom, and many of the Worcestershire agriculturists have their mowing and reaping machines, horse-rakes, wheel-ploughs, &c., to say nothing of steam-cultivators. But we must not be too censorious with the farmer for not adopting every new implement brought into notice, when we see so many inventions only made public to be proved failures; and it is not to be wondered at if a farmer, having burnt his fingers once or twice, be very careful not to purchase expensive articles until their value has been fully proved.

One of the most important improvements that have taken place on light land is the wheel-plough. By it the land is more evenly ploughed and to a greater depth, the sod better turned in at the edge of the furrow, and consequently less couch-grass grown. The drill has almost entirely superseded the seed-lip.

Chaff and turnip cutters and root-pulpers are in common use. The system of trials and prizes adopted by the Royal Society has done much to promote such improvement. What independent person has seen the interest shown at the Society's implement-trials but must confess that few farmers can return home from them without being better enabled to form a sound opinion for themselves as to the implements best suited to their own requirements, even if they may differ from the appointed judges in their decision.

At the very least the farmer has this important advantage, that if the prize implement is not always that which will suit him best, the worthless ones are either at once rejected or their owners do not dare to compete publicly.

Perhaps the most absurd custom that retains its hold in Worcestershire in the eyes of a stranger is the putting of four and often five horses with a man and a boy to plough with a wooden plough, having a wooden board; but this plough has not yet been superseded by a better. Some of the soil (Lias) is of so tenacious a character that the furrow will not slip freely from iron; still the practice of putting five horses in wet weather to plough some five inches deep must be condemned.

Steam Cultivation.

Steam cultivation does not appear to increase in favour with our farmers; one cause of this is that the holdings are small, and

the cost of hiring comes too high, except just at a push after harvest: still in this respect the late Meeting of the Royal Agricultural Society promises to be a new epoch in the history of the county. Most gentlemen who visited the scene of the trials at Wadborough must remember the way in which the soil was broken up; I, for one, thought that from the quantity of clay brought to the surface the field was ruined; but Mr. Smithin informs me that although hitherto he has not grown any better crops, yet he does not think any injury has been done to the land, and probably in another year or so there will be an increase in the produce. Although a first-class farmer, Mr. Smithin does not himself cultivate by steam.

The principal employers of steam-tackle are Mr. Randell, Chadbury, near Evesham; Mr. Higginbotham, Pensax; Mr. Alsopp, Hindlip; Mr. Humphries, Pershore; Messrs. Green and Co., Newtown, near Worcester; and Mr. Bonford, Pitchill, near Evesham. The latter gentleman, who farms 800 acres of land, partly on the lias formation, and partly on the new red sandstone, has been one of the most energetic promoters of steam cultivation, using first the Woolston system, and latterly two engines with cylindrical drums surrounding their boilers, to work Fowler's plough, or Howard's cultivator. His aim is to combine stifle burning with thorough cultivation, and thus to grow two green crops instead of one, or, indeed, instead of a bare fallow. His proceedings are described at length in Mr. Morton's Almanack for 1865; this subject has been so thoroughly discussed of late in this Journal, that this short notice may now suffice.

Orchards.

The orchards of Worcestershire form a pleasing contrast to the monotony of some counties, and although in many places they are neglected, yet the increasing demand for fruit in the manufacturing districts tends to make these the most paying of crops, the orchard, when once planted and out of the reach of stock, causing very small annual expense. Such a scarcity of apples has never been known as during the winter of 1865 and 1866: ordinary apples were then selling in Hereford in January at 1*d.* each. Special attention should be paid to the cultivation of sorts that will keep till spring; also to red apples, for which there is an increased demand. Most of the western side of Worcestershire is particularly suited for the growth of apples, and even more so for that of pears; but the pruning and dressing of the trees is too often greatly neglected. There are not so many young orchards being planted as we could wish to see.

Many of the best orchards on the western side of the county

have been reared in hop-yards; the plants are set in rows so as not to interfere with working the ground between the hops: when they are nursed into trees the hop-yard is done away with; the land is then worked for a few years as tillage, and afterwards laid to grass. Trees in orchards that have been worked as arable often do not bear as well if the land is laid to grass, but get covered with moss, principally from want of vigour to throw it off.

When an orchard dies out it should not, as a rule, again be planted with the same kind of trees. The reproduction of apple-trees from the pip is hazardous, the produce being commonly a compound of the parent tree and the original crab; hence seedlings are mostly grafted with the kind required.

Many people lay stress on the selection of those sorts which bear sweet fruit or those with a high specific gravity of juice; this, as far as my experience goes, is a great mistake. In the first place sweet sorts produce a cider which it is generally difficult to fine (this is especially the case with sweet pears), whilst those which produce cider of a high specific gravity give such a small quantity of it, and are generally such shy bearers, that they are not to be much recommended, although a few may be desirable for a mixture with other kinds. The system usually followed in planting out an orchard is to take some good stocks, the stems of which should be two inches in diameter: these are planted out in November or December, the field being first drained. The stocks should be planted in rows ten or twelve yards apart, so that whichever way you look you may see up the rows; they should be afterwards protected from cattle and sheep. They may then be grafted, as much care being taken in the selection of grafts from healthy trees as you would in the selection of a male animal for use in your flock.* The young graft must be protected from the winds and from stock, and should be trained to form a fine head. The degree of pruning to which trees are to be subjected depends on the quality of the fruit required. If you want size and maturity, keep the trees open and thin; if quantity, then leave the branches thick. The planting and rearing of an orchard will cost from 6*l.* to 12*l.* per acre before the trees get to full bearing. No tree should be planted which is less than 1½ inch in diameter, or of less height than will allow of its being grafted at least 6 feet from the ground; if it is intended to graze cattle in the orchard the trees should be 7 feet high.

A practice is gaining ground of whitewashing the bodies of

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* Having seen the beautiful wood in some of the dwarf apple-trees supplied to Anthony Bubb, Esq., of Witcombe Court, near Gloucester, by Mr. Rivers, of Sawbridgeworth, which have been grafted on Paradise stocks, we would suggest that it may be possible to get back many of the old sorts of fruit which are dying out, by regrafting on some of these stocks.

the trees and then putting a coating of tar all round them, about 6 inches in depth, at the height of 2 or 3 feet from the ground, with the design of keeping the insects from ascending the trees and thus preventing their being blighted. This black band upon the whitened body gives the trees a peculiar appearance; I am unable to speak as to its effect, but those who use it seem to have great confidence in it.

The making of cider and perry is an important branch of the farmer's business, especially on the western side of the county. But there, as in other cider districts, sufficient attention is not paid to keeping the fermentation down, as is usually done by racking and other processes. This is not difficult on the deep clays and loams having a good deep subsoil; but on the lighter soils it requires great attention to produce a first-class cider, as the fruit on these soils naturally contains overmuch of malic acid, and probably of vegetable ferment likewise.

Cider has usually been made in the old-fashioned circular mills, which have their advantages. These, however, are being gradually superseded by the double-roller mills, which are sometimes taken from farm to farm. The greatest objection urged against them is, that this often leads to the fruit being ground too green and time not being allowed for the juice to absorb the flavour and other qualities from the rinds and kernels, whereas in the old circular mills the grinding is continued for two or three hours; but where proper precautions are taken to let the fruit ripen well, and to keep the pulp for six hours after grinding, or till the morrow, before pressing it, a much better cider is produced.

For fuller details of its manufacture, I must refer the reader to my Essay in the 'Royal Agricultural Society's Journal,' Vol. xxv., page 76.

In the gardens near Evesham and Pershore large quantities of plums (damsons and damascenes) are grown, together with gooseberries and currants. The plums are largely used for dying cotton prints: they contain a peculiar acid, which particularly adapts them to this purpose.

Hops.

The Worcester hop district contained in 1861 (the last year in which any return was made for duty) 5869 acres, which was listributed as follows:—

	Acres.
Gloucester	2
Hereford	3638¾
Wales (middle)	22
Stourbridge	1184¾
Worcester	1021½
Total	5869

I estimate the subsequent increase at 20 per cent., including the hop-yards planted up to the present time, as the abolition of the hop duty has given a great impetus to planting. This would give a total at present of about 7000 acres.

Fresh hop-yards are being planted on every side, and the demand for poles during the season of 1866 was very large.

The duty paid in this district has varied in a very extraordinary manner: in 1823 only 4*l.* 3*s.* 1¼*d.* was paid; in 1840, 240*l.*; while in 1846 the sum reached 36,008*l.*, and in 1857, 35,930*l.*; but the duty is not a criterion of profits. The most profitable years are those when there is a failure in Kent and other districts, and a moderately good crop here.

On the poorer class of farms hops are often injurious, in consequence of the whole stock of manure being expended on them: this inclines many landlords to forbid their growth; but the evil, I think, may be avoided by compelling the tenant to dress the hops with artificial manure; and this would be to his own advantage, for bone-manures do not stimulate the growth of the tender bine as much as ammoniacal-manure, and consequently the plant has more strength to withstand the blight and produces a better sample.

The cost of planting a hop-yard is about 50*l.* per statute acre:* poling costs 30*l.* to 40*l.*, and the expense of cultivation is about 20*l.*, besides kilns or oasthouses. Much difference of opinion exists as to the best system of planting, whether in rows or on the square: in the former the rows are 7 feet apart and the stocks 3 feet apart in the row; a greater quantity can no doubt be grown on the land in this way. On the square system the stocks are planted 7 feet apart each way; this is preferable where the land grows many weeds or requires much cultivation to pulverise the soil, as it admits of working both ways between the poles. In poling the hop-yard the great object is to set the poles in such a manner that their tops are equidistant from those in other rows. Two advantages are thereby gained: first, the sun-light is equally distributed, which is essential for a good sample (the most exposed growth being the best, and those inside the worst); and secondly, the bines are not so liable to tie each other together.

The best hops are produced in the parishes of Lye, Alfrich, and Lulsley.

An eminent hop-merchant informs me that the farmers should pay more attention to their kilns, drying, and picking, and says there is generally a want of kiln-room. He also says that the form of the kiln is not of so much importance as to have the hops

* The local hop-acre is 1000 stocks, irrespective of area or distance.

a good way from the fire, to avoid all risk of burning, with plenty of head-room for the escape of the vapour, as, if the steam falls back upon the hops, it makes them of a dull colour. Another practice to be much condemned is the old system of beating and breaking the hops; but this is gradually falling into disuse.

The principal growers are Mr. Smith, of Wick; Mr. Woodward, of Bredon; Mr. Twinberrow, Knightwick; Mr. Walker, Knightwick; and Mr. Dix, Lulsley.

Several attempts have been made to supersede hop-poles; but the result is yet undetermined. Cocoanut-fibre has been tried with some amount of success; but the likeliest plan is the use of galvanised wire, as patented by Mr. Farmer, Kyre Wood, near Tenbury. Mr. Farmer claims these advantages:—That the hops ripen earlier, are more equal in size, and of greater bulk; that, clinging firmly to the wire, they are less injured by high winds; that they can be cut higher with less damage to the root; that the yearly expenses of pitching, tyeing, and piling the poles is saved. "The essence of the invention consists in arranging vertical or nearly vertical wires between horizontal wires for the training and growing of hops." The following illustration shows this plan as commonly pursued:—

At each end of every row of hops is placed a strong pole, similar to a telegraph pole, but stronger: these poles are supported firmly by stays, with a similar but smaller pole at a distance

of about 60 yards in the rows. At the top of each pole is a horizontal cross-piece, from either end of which one horizontal wire (No. 1) is stretched to the cross-piece of the next pole. Near the bottom a third wire is stretched (No. 2) from pole to pole; to these three horizontal wires other and nearly vertical wires are attached, their lower end being fastened to the lower horizontal wire, and the upper end alternately to one or other or the two upper horizontal wires.

It is calculated that the poles and wires, being permanently fixed, will last at least twenty years, and the first cost is stated to be little, if at all, greater than that of a good poling. A royalty of 3*l.* per acre is charged, and the patentee will instruct and assist the grower.

The cost of the above was stated to be 33*l.* per acre; but as it has been found necessary to increase the size of some of the wires, it may extend up to 40*l.* per acre. It is difficult to estimate exactly the comparative cost of poles or wires, much depending on the amount of annual repair which the wire will require within the twenty years it is supposed to last. Poles within the same period would require two renewals, viz., at the end of seven and fourteen years, costing each time for poles 28*l.*, creosoting 2*l.*; in all 90*l.*, apart from the question of the interest payable. When poles are used, there is the expense of hauling; and they have to be sharpened and put up, besides being moved to work the land in the spring, which items involve a large annual expense. There is this distinction between the wire and the pole, that if each be 13 feet long, it will take a longer bine to reach the top of the pole than to climb the wire. Authorities, however, are not agreed as to whether it is better for the hop to *overtop* its support or to have a longer prop; and I have not made up my own mind on the subject. A third point to be considered is the tying: the bine clings so naturally to the wire, that when once started right it requires no more attention. In the question of picking I apprehend there would be very little difference as regards cost, from the crop being picked off the wires on a moveable frame; but the wires have, in my opinion, an immense advantage, because, unlike the poles, they do not require the bines to be cut. This cutting, while the sap is up, must weaken and injure the root, and damage the following crops; to this cause we may to a great extent attribute the want of so much manure to stimulate the plant and also the deterioration of the old hop-yards; for we see no reason why, with proper management, a hop-yard should ever become exhausted. For some years many of the leading hop-growers have been aware of the injury done to the root by cutting the bine, and have consequently had them cut off as far from the ground as possible. It is also remarked that in those parts of the

hop-yard where picking is commenced the roots are always weaker the next year, and this is attributed to the bleeding of the roots of the first bines cut whilst they have so much sap in them; to obviate this as much as possible they do not commence picking two years together in the same part of the hop-yard.

I have briefly given my impressions after seeing Mr. Farmer's system and talking the matter over with various persons; but we must wait awhile before we can confidently say it is a success, for the bine on the iron wire may be affected by lightning, sharp frosts in May, or other circumstances, and this can only be tested by experience: still its promises are so important, that if I were a large hop-grower I should certainly try the system on a few acres.

Occupancy.

The holdings as a rule run from 200 acres to 250 acres, and yearly tenancies prevail, the times of entry are pretty evenly divided between Candlemas, Lady-day, and Michaelmas, the former probably being the least common. With the two former the tenant at leaving plants one-third or one-fourth the arable land with wheat, which he harvests, retaining a portion of the barns and granary for that purpose, but the straw belongs to the incomer. He also retains the house, yards, and buildings, and a boozy pasture till the 1st May, giving up a room in the house and stable room, for the incomer's men and horses to enter upon to work the land.

With the Michaelmas entry there is no away-going wheat crop, the outgoer consumes his roots, hay, and straw, and retains the yards with a portion of the buildings and boozy pastures. He is also paid for work done on the tillages. The incomer plants the wheat.

There is a custom in some places, by which with the Candlemas and Lady-day takings the incomer takes a portion of the wheat crop without paying for it. If the wheat is planted after a fallow he only takes every third stock; otherwise every other one, the outgoer having to cut it.

These customs are very conflicting, and I hope to see them done away with, arrangements being made for the incomer to take the crops, &c., by valuation; then it would matter little whether a spring or autumn taking prevailed. With clay land the latter is probably the better time; but on sheep and turnip soils, the former is preferable, as so many of the roots must be consumed on the land. Whichever system may be adopted, I strongly recommend that a liberal payment be made to the tenant who leaves his farm in a good state. He should be paid for all the manure purchased in his last year (except nitrate of

soda), and for half the corn consumed by his stock. The great object to be sought is to get him to expend his money and cultivate his land as if he were going to keep it; and that is the best agreement which makes it his interest to do so; for if he exhausts his farm, it costs the incomer double the money to get it into proper condition again. The landlord also loses by his farm being in a poor and impoverished condition when he tries to let it to a new tenant, whilst if the outgoing tenant knows he is to be remunerated fairly for his expenditure, and also get a further benefit in his crop, he will be sure to avail himself of his chance; the extra straw and the manure left will be for the benefit of the farm, as only the corn is sold off.

The Labourer.

The labourer's condition is better in Worcestershire than in some of the adjoining counties; indeed in some districts his condition and intelligence are quite superior; this may be accounted for by his contact with his manufacturing brethren. His wages vary from 9*s* to 11*s*. per week, but they are swelled by perquisites and extras to 14*s*. or 15*s*. The bailiff, carter, and shepherd have cottages rent-free.

The system of task-work is gradually gaining ground, and we should be glad to see more done in this direction; it stimulates the good labourer to do his utmost, whilst the slothful man must do a fair day's work to earn his wages, or suffer the penalty of indolence; another advantage which is often lost sight of is, that when labourers are scarce, it leads to more work being done by each man, by his working overtime. The only drawback or disadvantage that I know of is, that the farmer himself must thoroughly understand the work to observe whether it is properly done, and to insist upon its being so done. This requires some firmness on his part.

Another point of great importance to be here discussed, is the system of giving the labourer drink. This varies from two quarts of cider per day in the winter to three quarts in the summer, with four at harvest and hay-making time, and when extra labour is required.

I have heard both sides of this question discussed, and I must confess that I see no good result likely to arise from the abolition of the existing system, unless the men voluntarily assent to it, or that all the beer-houses are shut up; for I have seen numbers of instances, where the men, having received only money payment, consider themselves entitled to spend the extra sum they obtain in drink; this leads to their visiting the beer-house, where they spend a great deal more than they should, besides acquiring

the evil habit of frequenting those places. I should reduce the quantity and strength of the cider, for in years of plentiful fruit the scarcity of casks leads to the cider being made so strong that the men cannot drink the usual quantity without showing its effects. This, I think, is as much the fault of the farmers as the labourers, and it has been specially seen during the past year in contrast with four or five years before.

The system of letting large allotments to the labourer I consider to be unwise; for he cannot, as a rule, cultivate the land as it ought to be done, and serve his master properly, whilst competing with him by spade labour, and necessarily paying a higher rent; as a rule, his allotment should not exceed a quarter of an acre; this is sufficient to employ his odd time, and if he has more he must lose his wages by stopping at home to work it; he then soon begins to select out fine days for this purpose, and those are the very days when the farmer is busy, thus an ill-feeling is engendered between master and servant, which would not otherwise arise.

Great advancement has been made in the education of the labourer, but this might be further improved in a way which the farmers would cordially approve. We all admit that children should have their faculties exercised, by committing something each day to memory; I would therefore suggest that books should be published specially for country schools, in which all the reading, spelling, &c., should bear upon subjects connected with the farm, so as to make the boy familiar with the names, make, and use of things which in after life he will have constantly to deal with. Such a boy, knowing all the different parts of implements, &c., would, when he leaves school, be of more value to a farmer than at present, for he would have learned more, and would take more interest in learning.

The Labourers' Cottages.

In many parts of the county the cottages are built of brick and covered with tile, and have a nice garden and plenty of room; but in others I have observed poor miserable huts, with a chimney built of stone and mud, the rest being timber, covered with thatch, with only one room up-stairs and one below, for all the family to live and sleep in, and I am sorry to say very many of this class are to be found.

The cottages on the eastern side of the county, are to a great extent congregated in villages, as at Inkberrow, Bishampton, &c., but this often involves a long distance for the labourer to walk to and from his work; sufficient cottage accommodation on every farm for the labourers required upon it is preferable.

Woods and Plantations.

Perhaps ordinary coppice-wood is the least profitable use to which land is put; for if we value the land after it is cut at only 20*l.* per acre, with 2*s.* 6*d.* rates, 2*s.* 6*d.* tithes, and 1*s.* per acre for woodward, to make up compound interest at only 3 per cent. for something like 15 years, each fall should produce 17*l.*, and only a very good coppice will average this sum. But when some good growing oak is produced, and stands thickly upon the ground, it pays very well. This is instanced in the old red sandstone at Kyre and Bockleton, near Tenbury, where some splendid oaks may be seen. In the same neighbourhood I have met with the best plantation of larch I have seen in the county, the trees being from 80 to 100 feet high, and I measured one in a plantation, either begun or finished on the day his Royal Highness the Prince of Wales was born, that girthed 4 feet 10 inches at the height of one foot from the ground. These plantations are very valuable where they grow freely, but they require to be planted thickly, and to be judiciously thinned as they attain size. Another profitable plantation in the hop district is the ash-bed. These are commonly planted in rows 4 feet apart each way, and when fit to make hop-poles, sometimes average four to each stool; this as they are cut in seven or eight years is very remunerative, especially when they realise 20*s.* per hundred, and produce 8000 or 10,000 per acre. The cost of planting an ash-bed is very moderate; the young trees can be had at 35*s.* per thousand, the labour of planting costs from 25*s.* to 30*s.* per acre more. The following system is recommended to me by a gentleman who has paid considerable attention to the subject. If the land you propose to plant is wet, it should be ploughed up in ridges, and the ash planted on the top; if not, the ash may be planted in rows, 6 feet apart, and 3 feet in the rows. Between these rows set a row of larch. When the ash has been planted two years, they should be cut within an inch of the ground, as if left they will take long to grow into one hop-pole, whereas if cut off after getting good root, they shoot out with such energy that you get some good poles in ten years. The larch having helped to nurse up the ash should now be cut, as they will be of good size for hop-poles, and command 5*s.* per hundred more money than other poles, they will thus pay the expense of planting the ash-bed.

In many of the hop districts alder, grown on the farm, is, as a matter of course, used for hop-poles; but they are seldom bought if any other kind can be obtained without much hauling; even when of home growth they are not desirable, as it will take two

or three to supply the place of one good ash-pole, for they soon decay.

In a few places on the western border of the county these alder-poles are allowed to grow in clumps on the meadow-land, a system to be very much condemned, as the cattle bite off many of the shoots, thereby causing the growth of bad poles; and they also cause injury to the meadow-land, which had much better be drained and converted to a more profitable purpose.

If the alder is grown at all, it is much better to grow them in beds, where they can be kept well fenced from stock of all kinds.

Many parts of the county produce very fine elm timber, which being a free growing tree, generally pays better than oak, though only realizing one-third the price.

Chesnut is also a valuable wood, both for hop-poles and hurdles. In sheep districts there is always a demand for these hurdles, for, though much lighter, they are as durable as oak: indeed some people affirm that chesnut will last longer, as the oak is felled with the sap in it. The chesnut must not be left to get too old. Young chesnut is also good for farm gates.

In the neighbourhood of Bewdley there are immense forests of oak coppice. Here large quantities of charcoal are made, but the greater part of these forests is in Shropshire.

Great injury is frequently caused to coppice-woods by allowing cattle and sheep to bite off the young shoots; damage to the extent of many pounds may be done in a few minutes—great attention should therefore be paid to the fences.

A great mistake is also committed in allowing ivy to grow upon timber; however ornamental it may be, it occasions much injury to the timber. If wood is kept for coppice, many large oaks should not be allowed to remain, for nothing grows under them. One timber tree, three princes, six double stores, with plenty of smaller size, are enough to stand per acre.

The fences in this county, as a rule, are good, more especially on the Lias, where the quick grows remarkably well; on the good land many of the old fences have been removed, and new straight ones substituted.

To give some idea of the rapidity of growth of the white thorn under favourable circumstances, I may state that I measured the length of one summer's shoot in a hedge near Mr. Willet's, of Bishampton farm, which was 6 feet 3 inches.

Taking the county through, there is an absence of the hedgerow timber which is such a hindrance to good farming in many places

Results of late Meetings.

Before the Royal Agricultural Society held its Show at Worcester the county was very backward, both with exhibitors and prizetakers; and furnished in 1861 only 43 members to the Society, but a list published since the Worcester meeting shows that the number is increased to 168. This is one of the indirect advantages that the Society gains by its peripatetic meetings.

In conclusion, the writer tenders his thanks to those gentlemen who have so kindly favoured him with information on the different subjects discussed, trusting that any criticism he has penned may not offend. May we all see more improvement made during the next twenty years than has been effected during the last, great though it has been.

X.—*Town Sewage.*

The Royal Commission on the "Sewage of Towns" has lately published its third Report, and the Journal of the Chemical Society has printed an article by Messrs. Lawes and Gilbert, embodying, in a popular form, the leading points involved in this subject.

The same authors contributed to this Journal (1st Series, Vol. xxiv., p. 65) an article based on the second Report of the Commission, exhibiting many of the chief results obtained by the use of sewage on grass at Rugby in 1861, results which the later Reports confirm by the larger experience of subsequent seasons of remarkably diversified character.

It is now proposed to give, in a somewhat condensed form, the substance of the communications made to the Chemical Society by Messrs. Lawes and Gilbert.

The problem is thus enunciated: How to dispose of the "excreta" of large populations in such a manner as to secure their collection and removal without nuisance or injury to health, together with their economical utilisation for the reproduction of food. Hitherto, where utilisation has been most complete, comfort and health have been overlooked; where removal *from the dwellings* has been most rapid and complete, other objects have been sacrificed.

China and Japan are frequently cited as examples of "utilisation," but their arrangements are such as to be quite irreconcilable with our modern notions of cleanliness, decency, comfort, and health.

Belgium has also been referred to: "indeed, in one of the applications made only last year to the Metropolitan Board of

Works for the concession of the southern sewage of the Metropolis . . . . . it is stated that the excretal matters sell in Belgium for over 1*l.* per person per annum."

There is no doubt that in some parts of Belgium the solid, and a portion of the fluid excrements of the town populations are collected, as free as possible from extraneous water, in receptacles of more or less perfect construction, and periodically removed for application to the land, and that the land so fertilised is very productive. From observation and inquiry made in some of the towns in question, it may, however, be safely affirmed, that the practices adopted are attended with more nuisance and discomfort than would be permitted in this country; that a considerable portion of the urine escapes, and that in no case did the town population realise a return which averaged 1 franc per head per annum.

This estimate of money-value is confirmed by a Prussian Commission, which, after visiting Ghent, Ostend, and Antwerp, and likewise Hanover, Cologne, Metz, Carlsruhe, Strasburg, Basle, Lyons, Zurich, Munich, Nuremberg, Dresden, and Leipzig, made a report which shows not only that the householders seldom realised anything like a franc per head per annum, but that in most cases it cost them something for the removal.

Nevertheless, the Commissioners, looking to the local circumstances of Berlin, and to the results of the water-system in this country hitherto, recommend the use of such a barrel as two men can carry, placed at the bottom of a shaft leading from the closets, which, when removed, is covered with a close-fitting lid; they anticipate little nuisance or discomfort, and little profit, but hope by these means to secure much valuable manure in an available form.

In addition to this foreign evidence, it may be well to mention two attempts made in England to obviate the use of water, and thereby to procure a concentrated dry and portable manure.

Perhaps the most noticeable attempt is that which has been made at Hyde, in Lancashire, a manufacturing town of more than 20,000 inhabitants. Some few years ago a company contracted to carry out here what they call the "Eureka system." They provided boxes (supplied with some disinfecting or deodorising mixture, to be fitted in at the back of the closet) for nearly every house, leaving scarcely a water-closet in the place. The box, which is to be reserved strictly for its proper use, is exchanged for a fresh one after a certain number of days. When removed, it is covered with a closely-fitting lid, and so transported in a closed van to a manure manufactory close to the town. Here the matters are first well mixed, and then strained to remove

rags, which are washed and sold for paper-making. *More disinfectant* is then added, and the matter concentrated *by distillation*, the distilled water being sold to dyers and bleachers. The residue thus thickened is then mixed with coal-ashes, which are collected in the houses in casks left for the purpose, and are re-burnt in a reverberatory furnace, and finely ground before being thus used.

It appeared to Dr. Gilbert, on visiting Hyde in 1863, that the mode of collection and preparation adopted was attended with very little unpleasant odour. The advocates of the system maintained that it had been successful in a sanitary point of view. As to this, however, some difference of opinion existed.

The system is still in operation. It has encountered opposition in a legal shape; but this "had reference not to the mode of collection, but to the conducting the manufacture so near the town."

However, the manure manufactured is by no means satisfactory, for a sample analysed at Rothamsted contained only between one and two per cent. of ammonia.

One more dry system calls for a notice—that of the Rev. Mr. Moule, already propounded in this Journal.* It professes that by the deposit on the fæcal matter of dry and finely sifted clay (4 lbs. per head per day), it may be at once entirely deodorised, and in a few weeks so entirely disintegrated, that neither excreta nor paper can be detected in the mass, which looks like fine earth, and after resifting, may be re-used, until it has done service four times over.

However available this system may be for sick rooms, detached houses, or even villages and small country towns, where the earth for preparation and absorption, and the land for utilisation, are in close proximity to the closet, "we are certainly not so sanguine as the Rev. Mr. Moule, who seems to think that with the aid of Earth-closet Companies, his plan is as practicable for large towns as is the supply of water, gas, and coal at present, and much more so than the removal and utilisation of dilute town sewage."

This rapid survey of the dry methods of utilisation may suffice; they have this common drawback, that much of the urine (which is a very valuable part) escapes; for little beyond that passed once a-day with the fæces is secured. Moreover, either the nuisance created is considerable, or the manure produced too bulky to pay for long transport. We therefore pass on to

The Water System.

Whatever be its short comings hitherto, this is the path of

* See Series I., Vol. xxiv., p. 111.

progress; though scarcely more than a generation old, it has already increased our domestic comfort, and our immunity from zymotic disease, as statistics abundantly show. If, so far, it has sacrificed the manure and injured our rivers, there is more hope for amendment in this modern system than in that which the lapse of ages has failed to rectify. Practically, therefore, our problem assumes this shape—how shall we deal with dilute town sewage, the foul stream which flows through the underground veins and arteries of our great cities?

Portable Manure made from Sewage.

Many plans have been proposed for the separation of the valuable constituents from sewage-water. Some of these have succeeded in separating the whole of the insoluble or sedimentary matter, and even some small portion of the soluble constituents, leaving the fluid to a great extent, or at any rate temporarily, purified; none have succeeded in either adequate or permanent purification, or in the separation of the more valuable manurial matters, and the production of a *concentrated*, dry, easily transportable manure, which may be redistributed over the extended area to the variety of crops from which its ingredients were first derived; moreover the great solubility of some of the more precious constituents precludes the hope of so desirable a consummation.

We have therefore to dispose of the sewage in a dilute form, and these questions arise:—

What is its composition and value?

What is the amount furnished by a given population?

To what soils and crops is it most applicable?

Composition and Theoretic Value of Town Sewage.

Widely different will be the estimates of value formed by [illegible]heorists who overloo[illegible]ll but the fact that so much of nitrogen, phosph[illegible] s to be found in sewage, and those of practica[illegible] tried to grapple with the unwieldy body in whic[illegible] diffused.

Fo[illegible] composition, two methods have been [illegible] taking samples of sewage, determining its [illegible]s, and then adopting such *estimates* as were [illegible] amount of sewage available within a given [illegible], by calculating the amount of fæces and urine [illegible]tuents) for a given population of different sexes and ages, with such adjustment for loss or for the addition of [illegible] fertili[illegible] circumstances suggested.

About three-fourths of the *theoretic* money value of the constituents of sewage is due to the ammonia (or nitrogen reckoned as ammonia) which it contains. The relation of this ammonia to the other valuable constituents is nearly constant, consequently the same result is obtained by ascertaining and valuing the ammonia, and then increasing the value so fixed by one-third as by elaborate calculations, including all the constituents. It appears that 8*d.* per lb. of ammonia, or one farthing per ton of sewage for every grain of ammonia per gallon, would fairly represent the total value of the manure as *thus determined.*

After much hallucination, authorities have come pretty nearly to an understanding as to the average composition of London sewage.

In the summer of 1863, Baron Liebig, adopting as the basis of his calculations an analysis of the Dorset Square sewage by Mr. Way, which showed nearly 18 grains of ammonia per gallon, estimated that (with such an addition of phosphate as he considered requisite to render the whole of the ammonia available) the constituents in 1 ton of sewage of that composition would be worth about 4*d.* Now, according to the estimate stated above, 18 grains of ammonia per gallon would indicate a value of 18 farthings, or 4½*d.* for the total constituents in 1 ton of the sewage.

In January, 1865, Baron Liebig assumed the average sewage of the metropolis to contain only 7·2 (instead of 18) grains of ammonia per gallon! and he estimated the value of the constituents in 1 ton of such sewage to be rather over 1¾*d.* Our estimate would also give rather over 7 farthings, or 1¾*d.*

In 1857, Messrs. Hofman and Witt concluded from their investigations that the average *dry-weather* sewage of the metropolis contained about 8·2 grains of ammonia per gallon; and taking into account the ammonia, organic matter, phosphoric acid, and potassa, valued one ton at about 2·11*d.*, a sum almost identical with that resulting from our *theoretic* estimate.

The estimate of Messrs. Hofmann and Witt, be it remarked, applied to the normal dry-weather sewage (about 158,000,000 tons per annum), yet it was adopted by Mr. Ellis in his application for the concession of the metropolitan sewage, as applying to the whole amount of dilute sewage (inclusive of rainfall and subsoil-water) 266,000,000 tons, and his calculations of profit to his company, and to the rate-payers were based on this erroneous assumption.

Baron Liebig likewise based his estimates on the *total* sewage supply.

The following Table indicates the remarkable fluctuations, according to circumstances, in the composition of London sewage, and the consequent danger of hasty generalisation.

TABLE I.—Grains of Ammonia per Gallon in different samples of Metropolitan Sewage, and estimated Value of Constituents in 1 Ton.

Authority.	Name of Sewer.	Time of Sampling.	Ammonia per Gallon.	Estimated Value per Ton.
			Grains.	*d.*
Way	Barrett's Court	Day ..	41·28	$10\frac{1}{4}$
	Dorset Square	Day ..	17·96	$4\frac{1}{2}$
Letheby	The Fleet	Noon ..	5·15	$1\frac{1}{4}$
		Midnight	8·50	2
	London Bridge	Noon ..	6·69	$1\frac{3}{4}$
		Midnight	8·10	2
	Dowgate Dock	Noon ..	10·03	$2\frac{1}{2}$
		Midnight	3·43	$0\frac{3}{4}$
	Iron Gate	Noon ..	8·13	2
		Midnight	6·20	$1\frac{1}{2}$
	Paul's Wharf	Noon ..	12·01	3
		Midnight	3·13	$0\frac{3}{4}$
	Whitefriar's Dock	Noon ..	5·35	$1\frac{1}{4}$
		Midnight	3·41	$0\frac{3}{4}$
	Custom House, West ..	Noon ..	6·25	$1\frac{1}{2}$
		Midnight	8·17	2
	Custom House, East ..	Noon ..	7·28	$1\frac{3}{4}$
		Midnight	15·01	$3\frac{3}{4}$
	Hambro' Wharf	Noon ..	7·69	2
		Midnight	5·69	$1\frac{1}{4}$
	Wool Quay	Noon ..	6·95	$1\frac{3}{4}$
		Midnight	5·00	$1\frac{1}{4}$
	Tower Dock	Noon ..	10·02	$2\frac{1}{2}$
		Midnight	7·15	$1\frac{3}{4}$
	Mean	..	7·24	$1\frac{3}{4}$
Hofmann and Witt	Savoy Street	24 hours	8·21	$2\frac{1}{16}$

The sample analysed by Messrs. Hofmann and Witt was a mixture of equal portions, taken every hour during twenty-four hours of dry weather, and there is no doubt that that sample had better claim to represent the average *dry-weather* sewage of the metropolis, than any other that had up to that time been collected and examined.

The variations in the composition of sewage are even more strikingly illustrated by the results obtained at Rugby, by the Royal Commission, from samples collected under the direction of Messrs. Lawes and Gilbert, and analysed in the laboratory of Mr. Way.

The samples were thus collected:—About a quart was taken from a gauge-tank holding 3 or 4 tons, at intervals of about two hours, for several days together; the quantity so accumulated was well mixed, and a sample of the mixture taken: ninety-three such mixed samples were analysed, the period of collecting extending over thirty months, from April, 1861, to October, 1863, inclusive.

TABLE II.—Showing the Highest, Lowest, and Average Amounts of Ammonia, and Total Solid Matter, in Mixed Samples of Rugby Sewage at different times.

		Ammonia.		Total Solid Matter.	
		Grains per Gallon.	lbs. per 1000 Tons.	Grains per Gallon.	lbs. per 1000 Tons.
From Apr. to Oct., 1861 ..	Highest	15·64	500·5	216·5	6928
	Lowest	2·99	95·7	37·6	1203
	Mean of 24 analyses ..	6·39	204·5	75·1	2405
From Nov. to Oct., 1862 ..	Highest	11·38	364·2	129·3	4138
	Lowest	2·55	81·6	50·5	1616
	Mean of 34 analyses ..	5·95	190·4	80·3	2570
From Nov. to Oct., 1863 ..	Highest	12·81	409·9	269·9	8637
	Lowest	3·14	100·5	62·2	1989
	Mean of 35 analyses ..	7·08	226·5	103·2	3302

According to our estimate, the value of the total constituents in 1 ton of sewage varied from about $\frac{5}{8}$*d.* to nearly 4*d.*

Notwithstanding the very great differences here exhibited, it is still believed that the mean of so many determinations indicates approximately the average composition of the Rugby sewage during the period. The difference in the average concentration of the sewage of the different seasons is perfectly consistent with the character of the seasons themselves. Thus the season of 1861-2 was much the wettest; that of 1862-3 was much the driest, indeed extremely dry; that of 1861 being intermediate in this respect, as well as in the strength of its sewage.

The mean of the 93 analyses showed about $6\frac{1}{2}$ grains of ammonia per gallon, indicating a total value of about $1\frac{3}{4}$*d.* per ton: but these samples had not been collected at exactly equal intervals; to correct any error which might hence arise, the mean of each of the 31 months was first taken, and then the mean of the 31 means so obtained; this adjustment indicated about 7 instead of $6\frac{1}{2}$ grains per gallon. The average results of the 93 analyses further showed that the sewage contained about $87\frac{1}{2}$ grains per gallon of total solid matter, of which about two-thirds was inorganic; and one-third organic. About half of the total solid matter was in suspension, and half in solution: of the half in suspension about four-sevenths was inorganic and three-sevenths organic, and of the half in solution, about four-fifths inorganic, and one-fifth organic. Lastly, of the nitrogen reckoned as ammonia, about one-fourth was in suspension, and three-fourths in solution.

From all the information at command as to the population contributing to the sewers, the water-supply, the rainfall, and the drainage area, it was concluded that, on the average, there

are about 60 tons of sewage per head per annum; but that, as the period of the experiments was drier than usual, the amount probably then reached only about 55 or 56 tons.

By reckoning the sewage at 60 tons per head per annum and the ammonia at 6½ grains per gallon, or the sewage at 56 tons, and the ammonia at 7 grains, we arrive alike at 12½ lbs. of ammonia per head as the contribution made annually to the sewage by a mixed population.

This was the estimate adopted in the Report of the Commission.

Let us now turn to the other method of computation referred to,—that based upon an examination of the fæces and urine, or of the food of man.

Table III. gives a very concise summary of the information we require.

TABLE III.—AMOUNT of Nitrogen reckoned as Ammonia, and estimated Value of Total Constituents, in Human Voidings, per Head per Annum.

		Ammonia.	Value of Total Constituents.
A.	Adult Males; Hofmann and Witt.		
		lbs.	s. d.
	Urine	15·8	10 0½
	Fæces	2·3	1 8¾
	Total	18·1	11 9¼
B.	Adult Males; Thudichum.		
	Urine	15·9	10 3½
C.	Average, both sexes and all ages; Hofmann, Witt, and Thudichum.		
	Urine	11·32	7 3
	Fæces	1·64	1 2¾
	Total	12·96	8 5¾
	[illegible] all ages; Lawes and Gilbert.		
	According to Food	12·2	
	According to Voidings	12·6	8 4
	According to Voidings	12·7	
	Mean	12·5	

(A.) To check their estimates founded on the analysis of the 24-hours' mixed sample of the Savoy Street sewage, Messrs. Hofmann and Witt applied to an estimate of the amount of urine daily voided by an adult the results of Berzelius' analyses of urine; for the fæces they took the record of the average amount voided by the body-guard of the Grand Duke of Hesse Darmstadt (but allowing, as they said, a little more for "John Bull"), and the analyses of Way, Liebig, and Wesarg.. The result so obtained for adult males they took as applicable to a mixed population of both sexes and all ages, assuming that other matters reaching the sewers would probably make up the difference—surely too liberal an allowance for such "other matters."

(B.) Some years later, in 1863, Dr. Thudichum, from much more comprehensive data, gave for the *urine alone* of an adult male 15·9 lbs. of ammonia, an amount almost identical with that of Messrs. Hofmann and Witt.

(C.) But Dr. Thudichum considered that two adult males would approximately represent 2·8 average persons, an adjustment which reduces the estimate of these two authorities to about 13 lbs. of ammonia, as shown in the Table.

In 1854 Messrs. Lawes and Gilbert, basing their estimate on very comprehensive data relating both to the food and also to the urine and fæces voided by persons of all ages and both sexes, set the ammonia at 10 lbs., and its manurial value at 6*s.* 8*d.* per head per annum.

More recently, for the Sewage Commission, they revised their estimates, bringing more recent information into account.

Section (D.) is the record of the results so obtained.*

The estimate, "according to food," was deduced from 86 dietaries arranged in 15 classes according to sex, age, activity of mode of life, &c. From the result (12·2 lbs.) a deduction must be made for the nitrogen retained in the body and for loss in various ways.

When the calculation was based on determinations or computations of the amount of constituents voided by different classes, the result was 12·6 lbs., or, when of the amounts of *fresh* urine and fæces taken at average composition, 12·7 lbs. of ammonia per head per annum.

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* For nearly the whole, if not the whole, of the data upon which the new estimates are based, see *On the Sewage of London*, by J. B. Lawes, F.R.S., 'Journal of the Society of Arts,' March 9, 1855; *The Composition of the Urine in Health and Disease*, by E. A. Parkes, M.D., 1860; *On an Improved Mode of collecting Excrementitious Matter, with a view to its Application to the benefit of Agriculture, &c.*, by J. L. W. Thudichum, M.D., F.C.S., 'Journal of the Society of Arts,' May 15, 1863; and *On the Elimination of Urea and Urinary Water, in relation to the period of the Day, Season, Exertion, Food, &c., &c.*, by Edward Smith, M.D., LL.B., F.R.S., 'Philosophical Transactions,' vol. cli. p. 747.

It appeared, however, that evidence was more plentiful in regard to some divisions of the population than others, and a careful consideration of the character of the results obtained in these several divisions led to the conclusion, that though their former estimate (10 lbs.) was probably too low, 12 lbs. was too high; and, due allowance being made for the fractional part of the excreta of horses, cows, dogs, and other animals, of the refuse of slaughter-houses, of soot, &c., that may reach the sewers, still not more than 12½ lbs. of ammonia would be contributed annually to the sewers from all sources, per head of mixed town population.

It was admitted, however, that further investigations, upon the completion of the main drainage of the metropolis, were a great desideratum.

Since the publication of the Report of the Commission, in March 1865, numerous gaugings and samplings of the sewage of the mid and high-level sewers north of the Thames have been undertaken, and many samples have been analysed by Mr. Way and Dr. Odling. The results of this inquiry have not yet been published; but such information was communicated by Mr. Way as enabled Dr. Gilbert to state their general bearing upon this point.*

From these new results it appears very probable that the dry-weather sewage averages only about two-thirds as much as was before supposed and assumed—that is to say 40, not 60 tons, per head per annum—but the average amount of ammonia therein very nearly approaches to the estimate of Messrs. Hofmann and Witt (8·2 grains).

The theoretical value of the constituents of sewage, or that assignable to them when constituting a dry and portable manure, is, as has been stated, obviously quite other than their realisable value when distributed through an enormous volume of water.

Assuming that the latest evidence is the most trustworthy, it would seem that the earlier estimate of Messrs. Lawes and Gilbert (10 lbs. per annum of ammonia) is the more correct, that at Rugby too large a proportion of the rainfall had been estimated to reach the sewers, and that the corrections made by Lawes and Gilbert to meet the incompleteness of their records, as already pointed out, were well founded.

Composition and Value of Metropolitan Sewage at different Dilutions.

To the dry-weather sewage very variable additions are made, according to rainfall, &c.; while, in time of continuous rain or

* Both Mr. Way and Mr. Cresy frankly admit, however, that there are still many open questions which materially affect the proper interpretation of the new gaugings.

storm, some water passes at once into the Thames. The total amount issuing from the sewers averages somewhere about 80 tons, and pretty certainly not more than 100 tons per head per annum; twice or twice and a half as much as the most recently estimated *dry-weather* flow.

The dilution is of course increased, and the value of the contents diminished to the same extent as the bulk is augmented, as the following Table shows:—

TABLE IV.—AMOUNT and Value of Sewage at different Dilutions.

Dilutions supposed.		If 12½ lbs. Ammonia, per Head per Annum, from all sources.		If 10 lbs. Ammonia, per Head per Anuum, from all sources.	
Per Head per Annum.	Per Head per Day.	Ammonia per Gallon.	Estimated value per Ton.	Ammonia per Gallon.	Estimated value per Ton.
Tons.	Gallons.	Grains.	Pence.	Grains.	Pence.
40	24½	9·77	2·44	7·81	2·00
60	36¾	6·51	1·67	5·21	1·33
80	49	4·88	1·25	3·91	1·00
100	61¼	3·91	1·00	3·13	0·80

80 tons of sewage to 12½ lbs. of ammonia would be equivalent to nearly 5 grains per gallon, value 1·25*d.* for the constituents in 1 ton; or 100 tons, to less than 4 grains, value 1*d.*

Since we are now discussing the *theoretical* value of sewage, a comparison with Peruvian guano may be useful, both to give a definite idea of the extent of the dilution and to test our estimate of value. If we reckon 12½ lbs. of ammonia and 40 tons of sewage per head per annum, 1000 tons of sewage will supply as much nitrogen, reckoned as ammonia, as 16½ cwt. of guano:—

	Ammonia.		Guano.
With 60 tons of sewage, and	12½ lbs.,	the equivalent is	11 cwt.
80 " " "	12½ "	"	8¼ "
40 " " "	10 "	"	13 "
60 " " "	10 "	"	8¾ "
80 " " "	10 "	"	6½ "

Reckoning 12½ lbs. of ammonia, the yearly sewage of an average individual would represent $\frac{2}{3}$ cwt.; or reckoning only 10 lbs., only $\frac{1}{2}$ cwt. of Peruvian guano. Guano is sold at about 13*s.* per cwt.

The true realisable value of sewage can only be arrived at by a careful investigation and comparison of the results attained under favourable circumstances with judicious management.

CROPS TO WHICH SEWAGE IS MOST APPLICABLE.

Hitherto we have confined our attention to the amount of nitrogen in sewage, as bearing a nearly constant ratio to the

other fertilisers in its composition. We now proceed to consider whether that composition is such as to suit the requirements of our crops; or, more precisely, whether its phosphoric acid and potash—the most important incombustible constituents—are relatively deficient or in excess for cereal, pulse, or root crops.

Table V. shows the proportion of phosphoric acid and potash to 100 of nitrogen in sewage, according to the mean of 10 analyses in the Rugby sewage. It also shows, approximately, the average proportion of phosphoric acid and potash to nitrogen in various crops:—

TABLE V.—AMOUNT of Phosphoric Acid and Potassa to 100 Nitrogen, in Sewage and in various Crops.

	Phosphoric Acid.			Potassa.		
Rugby Sewage ..	27			42		
	In Corn, Roots, &c.	In Straw, Leaves, &c.	In Total Produce.	In Corn, Roots, &c.	In Straw, Leaves, &c.	In Total Produce.
Meadow-hay ..	..	..	27	..	..	100
Clover-hay	..	..	23	..	..	52
Wheat	48	42	46	28	108	57
Barley	40	34	38	34	126	60
Oats	28	37	30	25	155	65
Beans	25	46	30	32	123	50
Mangolds	17	..	..	100	..	..
Swedes	27	16	21	82	44	63
Common Turnips	28	18	26	160	71	117
Potatoes	42	..	..	123	..	..

It is obvious that since the phosphoric acid of sewage, like the nitrogen, will be derived almost exclusively from excreta and food-refuse, its proportion to the nitrogen will be tolerably uniform; the amount of potash, on the other hand, will be considerably greater where the streets or roads are constructed of potassic minerals such as granite.

The Table [illegible] according to the analyses referred to, [illegible] 27 parts of phosphoric acid and 42 [illegible] nitrogen. Meadow-hay contains on [illegible] proportion of phosphoric [illegible] much greater proportion of [illegible] phosphoric acid to nitro-

[illegible] 31 parts of phosphoric [illegible] nitrogen, but having collated and averaged the results of numerous [illegible] observers, we can see nothing to lead to the adoption of such a figure; whilst direct determinations in a number of samples of each, showed in the Rugby [illegible] Note by Lawes and Gilbert.]

gen is, on the other hand, higher than in sewage. Of potash, the proportion is lower in the *grain*, the only part of the crop which is, as a rule, sold off the land.

After a seasonable word of caution about drawing *practical* conclusions from what may, at first sight, appear the obvious indications of the figures in the Table, these conclusions are drawn:—

That if sewage alone be applied constantly to meadow-land, potash would be more likely to fail than phosphoric acid; but for the ordinary crops of a rotation, the phosphoric acid would rather be in defect. In any case, the balance might easily be set right by supplies from other sources.

The composition of the manurial constituents in sewage is, therefore, generally satisfactory. The difficulty lies in their extreme dilution, and consequently the great cost of distributing them over an area at all commensurate with that whence they were derived; * and the necessity for a continuous outlet at all seasons, which cannot be afforded by crops which have to ripen —a difficulty aggravated by the fact that the supply is greatest in wet weather, when the land can least bear, or least requires it.

The Practical Value of Sewage.

This point will be illustrated by reference both to the results of direct experiment, and to the judgment of practical men, who have utilised sewage with a view to profit.

The Rugby Experiments.—At Rugby two fields of meadow-land were experimented upon; in each, one plot was left without sewage, one received sewage at the rate of 3000 tons, one at the rate of 6000 tons, and one at the rate of 9000 tons per acre per annum. The experiments were so conducted through three consecutive seasons, and Table VI. summarises the results obtained. (See following page.)

The 5-acre field was much flatter than the other; its soil and subsoil were much more porous. The mechanical and chemical examination of samples, taken to the depth of 9 inches, showed its soil to be much more stony, to retain much less water under equal external conditions, to contain much less organic matter, much less nitrogen, much less clay, and much more sand than that of the 10-acre field. It was, in fact, decidedly inferior in natural quality, and yielded, accordingly, considerably less

* Mr. Rawlinson, one of the members of the Royal Sewage Commission, has given it as his opinion that it would cost more to distribute 500 tons of sewage per acre, by means of pipes, hydrants, and hose and jet, as would be requisite in the case of application to arable land and crops generally, than to apply 5000 tons per acre by means of open runs, as in the case of its application to grass.

produce without manure. Notwithstanding this, it will b that it gave upon the whole more total produce per acre the influence of sewage than did the naturally better soil 10-acre field; and, it will be shown further on, that the was in its case both more completely utilised and mor pletely purified. Moreover, it appears that, by the appl of sewage, a supply of green food was obtained much earl much later in the season, when it has a special value.

TABLE VI.—QUANTITIES of Sewage applied, and of Green Grass ob per Acre per Annum, in Experiments made at Rugby.

Seasons 1861, 1862, *and* 1863.

Seasons.	Plot 1. Unsewaged.				Plot 2. 3000 Tons Sewage.				Plot 3. 6000 Tons Sewage.				Pl 9000 To	
	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	Tons.	cwts.	qrs.	lbs.	Tons.	cwt
Grass obtained.—Five-Acre Field.														
1861	9	5	3	5	14	16	3	8	27	1	0	10	32	16
1862	8	3	1	10	27	18	0	18	34	10	0	19	32	9
1863	4	18	3	13	22	5	0	11	34	18	1	27	37	0
Average	7	9	1	9	21	13	1	12	32	3	1	0	34	2
Ten-Acre Field.														
1861	8	18	0	15	15	16	3	2	22	15	2	12	26	13
1862	16	10	0	25	27	11	0	20	32	2	1	14	31	12
1863	8	0	3	19	25	5	1	8	30	11	2	12	34	19
Average	11	3	0	10	22	17	3	1	28	9	3	13	31	1
Averages:—The Three Years and both Fields.														
186[illegible] 2, and 3	9	6	0	24	22	5	2	7	30	6	2	6	32	12

[illegible] must [illegible] ...ted to the general c [illegible] ...tained [illegible] practical [illegible] ...clusions to [illegible]

W[illegible] ...season of 1862, the [illegible] ...he larger was the p[illegible] ...ll the [illegible] ...not commensurate w[illegible] ...ease of [illegible] ...plied. [illegible] produce a maximum effe[illegible] ...ven amou[illegible] sewage, the doses must be compa[illegible] ...mall; to pro[illegible] ...he largest possible amount of produ[illegible] ...re. 20,00[illegible] [illegible] 50,000 tons might often be applie[illegible]

advantage; but in that case the sewage would *be very inadequately utilised and purified.*

The Table leads to the following practical suggestion: that with an application of about 5000 tons of average sewage per acre per annum, applied pretty evenly throughout the year, taking the average of soils and seasons, an average of about 30 tons of grass might be expected. Assuming such a produce, and allowing 4*l.* per acre for rent or natural yield,

					d.
The grass, if sold at	10*s.* per ton,	would pay per ton of sewage			0·5
"	"	12*s.* 6*d.*	"	"	0·7
"	"	15*s.*	"	"	0·9

This would be the gross return from which the cost of the application of the sewage, other expenses of the crop, and the farmer's profit would have to be deducted, before anything was available as payment to the town.

In comparison with the result here assumed it may be observed that in the neighbourhood of Croydon, where about 250 acres are laid down for sewage irrigation, and where there are probably more than 6000 tons of sewage annually available for each acre, from 25 to 30 tons of meadow grass, selling for from 20*l.* to 25*l.*, are obtained per acre per annum; and after deducting as before 4*l.* for rent, the gross return per ton of sewage employed is from 0·6*d.* to 0·8*d.* With a somewhat similar application to Italian rye-grass, 30 to 35 tons, selling for from 25*l.* to 30*l.*, are obtained, yielding, after deduction for rent or natural produce, from 0·8*d.* to 1*d.* per ton of sewage employed. It will be observed that in these cases the selling price of the grass is 16*s.* or 17*s.* per ton; but it is obvious that if sewage were extensively employed for the production of grass, its present price could not be maintained.

A marked effect of liberal sewage irrigation (indeed of active manures generally) on the mixed herbage of grass land, is greatly to develope the *Graminaceous plants, nearly to exclude the Leguminous,* to reduce the prevalence of miscellaneous or weedy plants, but much to encourage individual species; among the grasses the rough meadow grass, couch grass, rough cock's-foot, woolly soft grass, and perennial rye-grass are frequently very prevalent. But, sewaged produce being generally cut or grazed comparatively young, the tendency which the great luxuriance of a few very free-growing grasses has to give a coarse and stemmy later growth is not an objection, as in the case of meadows left for hay.

The chemical examination of the grass grown at Rugby, with and without sewage, showed that at the usual time of cutting

the solid substance was less in the *sewaged* grass than in the unsewaged, and diminished as the season advanced, or the weather was ungenial.

The nitrogenous substance was much greater in the solid matter of the sewaged than of the unsewaged grass, also greater as the season advanced, and after periods of cold and wet.

The indigestible woody fibre bore about an equal proportion to the solid matter in the sewaged and the unsewaged produce; this proportion in each case diminished as the season advanced.

It will be seen presently that when used as food, the fresh unsewaged grass was more productive of both meat and milk than the sewaged, but that a given weight of the *solid substance* of the sewaged grass was more productive than an equal weight of that unsewaged.

When the grass was cut green and given alone to fattening oxen tied up under cover, the result was very unsatisfactory; but when oilcake was given in addition, it did not fall far short of an average result, for oxen so fed under cover on a good mixed diet.

It should here be mentioned that at Croydon, although the land there was more liberally irrigated than at Rugby, much more satisfactory feeding results have been obtained by fattening stock on the land. The practice there is to irrigate for three or four days and nights together, to repeat the treatment two or three times for each crop, and when the grass has got a sufficient head, to stop the application and turn the stock upon the land, where they remain until the grass is closely eaten down. They are then removed, the land is re-irrigated, and so on.

At Rugby, when the grass (as much as they chose to eat) was given to *milking* cows, much better results were obtained. The unsewaged grass was then found to be more productive of milk and increase (but especially of milk) than an equal weight of fresh sewaged grass, but for equal *amounts of dry solid substance* the sewaged [illegible] advantage. The milk from the sewaged [illegible] less rich—contained less casein, butter [illegible] matter, though more mineral [illegible] was given with the grass, whether sewaged [illegible] richness of the milk was notably increased.

[illegible] the grass was very different in [illegible] different periods of the same season, [illegible] inferior [illegible] cold season of 1862, and [illegible]

[illegible] is given in the following Table.

TABLE VII.—RESULTS obtained at Rugby, with Cows *fed* on *Unsewaged* and Sewaged Grass, in 1861, 1862, and 1863.

	Plot 1. Unsewaged.	Plot 2. 3000 Tons Sewage.	Plot 3. 6000 Tons Sewage.	Plot 4. 9000 Tons Sewage.
Time each Acre (with Oilcake, if any) would keep 1 Cow:—				
	Weeks.	Weeks.	Weeks.	Weeks.
1861—Grass (alone)	19	41	59	69
1862—Grass (with oilcake) ..	42	63	73	72
1863—Grass (½ without, ½ with oilcake)	22	48	67	73
Means	28	51	66	71
Milk from the produce of each Acre (exclusive of Oilcake,* if any):—				
	Gallons.	Gallons.	Gallons.	Gallons.
1861—Grass (alone)	321	571	820	961
1862—Grass (with oilcake) ..	613	835	973	958
1863—Grass (½ without, ½ with oilcake)	414	876	1207	1327
Means	449	761	1000	1082
Value of Milk from the produce of each Acre (exclusive of Oilcake,* if any), at 8*d*. per gallon:—				
	£. s. d.	£. s. d.	£. s. d.	£. s. d.
1861—Grass (alone)	10 14 3	19 0 6	27 6 11	32 0 10
1862—Grass (with oilcake) ..	20 8 10	27 16 10	32 8 11	31 18 10
1863—Grass (½ without, ½ with oilcake)	13 16 0	29 3 9	40 4 7	44 4 4
Means	14 19 8	25 7 0	33 6 10	36 1 4
Increased produce of Milk per 1000 tons Sewage applied (exclusive of Oilcake,* if any):—				
		Gallons.	Gallons.	Gallons.
1861—Grass (alone)	..	180	178	151
1862—Grass (with oilcake) ..	..	74	60	38
1863—Grass (½ without, ½ with oilcake)	..	154	132	101
Means	..	136	123	97
Increased value of Milk (at 8*d*. per gallon) per 1000 tons Sewage applied (exclusive of Oilcake,* if any):—				
		£. s. d.	£. s. d.	£. s. d.
1861—Grass (alone)	..	5 19 10	5 18 8	5 0 11
1862—Grass (with oilcake) ..	..	2 9 4	2 0 0	1 5 7
1863—Grass (½ without, ½ with oilcake)	..	5 2 7	4 8 1	3 7 7
Means	..	4 10 7	4 2 3	3 4 8

* The *value* of the milk, "exclusive of oilcake," is reckoned by deducting the cost of the cake consumed, less the estimated value of the manure it yields, from the gross value inclusive of oilcake;

After a careful consideration of all the circumstances and details, it appears that the following practical conclusions may safely be deduced from these experiments:—

1. That by the use of sewage a very great increase (varying from two to three fold according to the season), may be obtained in food, milk, or value of the milk.

2. That a yet larger *increase* may be anticipated from the application of sewage systematically over large tracts of average or sandy land, than was obtained from these pastures of naturally good feeding quality, and consequent high natural yield.

It is estimated that with 5000 tons of sewage judiciously applied to Italian rye-grass or meadow-land properly laid down to receive it, an average *gross* produce of not less, and perhaps more, than 1000 gallons of milk per acre per annum might be anticipated, which, at 8*d.* per gallon, would represent a *gross* money return of 33*l.* 6*s.* 8*d.*

Or, to put the result in another way, it required, according to circumstances, the consumption of between 5 or 6 tons of grass for the production of 1 ton of milk; and if we reckon 6 parts of grass for 1 of milk, and 30 tons of grass per acre, this would give a *gross* return in value of milk at 8*d.* per gallon, of something over 37*l.* per acre, or of about 25*s.* per ton, of grass consumed.

Composition of the Drainage Water from Sewage Fields.

But a further question arises:—would the sewage be sufficiently purified by such an application as 5000 tons per acre?

To determine this point samples of the drainage water were collected for analysis in each field simultaneously with those of the sewage, commencing in May, 1862, and ending in October, 1863. In all sixty-two partial analyses were thus made, to which a few others, much more detailed, were added in 1864.

The result of the sixty-two analyses are summarised in Table VIII. (See following page.)

It is seen that of matter in suspension in the sewage, nearly the whole, inorganic or organic, was retained by the soil, and of the little which the drainage-water contained, probably a considerable part was derived from the soil itself.

Of matter in solution, on the other hand, the drainage-water contained much about the same amount, inorganic and organic, as the sewage; though doubtless it had derived much of this also from the soil, the sewage giving up valuable fertilisers to the soil, and the fluid in its turn taking up substances from it.

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and the *amount* of milk, "exclusive of oilcake," by deducting from the gross amount of milk with oilcake at the rate of one gallon for every 8*d.* of deducted value. Such estimates are, however, [illegible]sly only approximations to the truth.

TABLE VIII.—MEAN Composition of the Rugby Sewage *before application*, and of the Drainage-water from the Irrigated Land, *in the Seasons 1862* and 1863.

Grains per Gallon.

Constituents		Five-Acre Field. Sewage.	Five-Acre Field. Drainage.	Ten-Acre Field. Sewage.	Ten-Acre Field. Drainage.	The Two Fields. Sewage.	The Two Fields. Drainage.
Season 1862; May—October, both inclusive.							
		11 Samples.	8 Samples.	11 Samples.	11 Samples.	22 Samples.	19 Samples.
In suspension	Inorganic ..	25·67	1·81	24·89	3·74	25·28	2·92
	Organic	14·69	1·40	17·14	1·39	15·92	1·39
	Total ..	40·36	3·21	42·03	5·13	41·20	4·31
In solution	Inorganic ..	34·49	34·50	32·38	37·10	33·44	36·01
	Organic	7·83	7·18	7·60	7·83	7·71	7·56
	Total ..	42·32	41·68	39·98	44·93	41·15	43·57
Total inorganic		60·16	36·31	57·27	40·84	58·72	38·93
Total organic		22·52	8·58	24·74	9·22	23·63	8·95
Total solid matter ..		82·68	44·89	82·01	50·06	82·35	47·88
Ammonia ..	In suspension	1·37	0·24	1·52	0·33	1·44	0·29
	In solution ..	4·13	0·80	4·26	1·85	4·20	1·41
	Total ..	5·50	1·04	5·78	2·18	5·64	1·70
Season 1863; November, 1862—October, 1863, both inclusive.							
		23 Samples.	21 Samples.	22 Samples.	22 Samples.	45 Samples.	43 Samples.
In suspension	Inorganic ..	39·41	2·14	34·93	3·93	37·22	3·06
	Organic	27·35	1·41	25·99	3·29	26·69	2·37
	Total ..	66·76	3·55	60·92	7·22	63·91	5·43
In solution	Inorganic ..	39·57	38·55	38·77	41·35	39·18	39·98
	Organic	8·35	7·46	8·30	7·98	8·32	7·73
	Total ..	47·92	46·01	47·07	49·33	47·50	47·71
Total inorganic		78·98	40·69	73·70	45·28	76·40	43·04
Total organic		35·70	8·87	34·29	11·27	35·01	10·10
Total solid matter ..		114·68	49·56	107·99	56·55	111·41	53·14
Ammonia ..	In suspension	2·08	0·15	1·98	0·31	2·03	0·23
	In solution ..	5·83	0·69	5·69	1·85	5·76	1·28
	Total ..	7·91	0·84	7·67	2·16	7·79	1·51

It is important to remark that the drainage from the more porous and less naturally fertile soil of the five-acre field (which, however, gave the largest increase for a given amount of sewage) contained less of almost every constituent enumerated than the more argillaceous and more naturally fertile soil of the more steeply sloping ten-acre field. The result is more particularly marked in the case of ammonia.

This and other results of common experience tend to show that a soil which may contain a comparatively small proportion of clay, but which is thoroughly porous, is as a rule much better adapted for sewage irrigation, both as regards the utilisation and the purification of the sewage, than richer, stronger, but less permeable land.

The next Table has reference to samples taken in another field at Rugby during very dry weather in the summer of 1864. The soil here was light and gravelly, the subsoil gravelly, but (as Table IX. shows) it had done the work of absorption as well, if not better than the other fields. (See following page.)

It had been intended to take samples under various conditions of the weather; but the continuous drought of 1864 prevented this being done. The plan of collection was to take of sewage about a gallon, and of drainage about half a gallon, eight or ten times during the ten or twelve working hours of the day; at the end of the day, after well shaking, to take a gallon from such mixture, and to repeat this for six consecutive days until six gallons of each were obtained, when, after well shaking, a two-gallon sample of each was bottled off for the purpose of analysis.

In judging of all these results it must be borne in mind that, except when the land is already saturated with water, a gallon of drainage will represent much more than a gallon of sewage, and its *sewage-constituents* must have been derived from more than a gallon of sewage. The non-retention of manurial matter by the soil is, therefore, less than might seem at first sight.

As [illegible] these the quantity of matter [illegible] small, and being obviously [illegible] was not submitted to [illegible]

[illegible] acid of the sewage [illegible] t in suspension in the [illegible]

[illegible] the larger pro- [illegible] likely to become deficient for a [illegible] the [illegible] smaller proportions of both [illegible] passed off in the drainage than [illegible] retained to a consider- [illegible], and lime less still. Of lime,

TABLE IX.—DETAILED Composition of Samples of the Rugby Sewage before application, and of the Drainage-water from the Irrigated Land, collected July, 1864.

	Constituents.	Grains per Gallon. Collected July 6—11. Sewage.	Collected July 6—11. Drainage.	Collected July 13—18. Sewage.	Collected July 13—18. Drainage.
In suspension.	Inorganic matter:—				
	Oxide of iron and alumina	4·57	..	6·30	..
	Lime	4·48	..	3·75	..
	Magnesia	0·65	..	0·25	..
	Carbonic acid	3·25	..	2·17	..
	Phosphoric acid	1·84	..	1·14	..
	Silica, sand, &c.	31·60	..	39·30	..
	Total	46·39	..	52·91	..
	Organic matter	40·40	..	32·40	..
	Total matter in suspension	86·79	..	85·31	..
In solution.	Inorganic matter:—				
	Oxide of iron, &c.	Traces.	..	1·25	0·25
	Lime	8·45	10·25	8·23	10·08
	Magnesia	1·76	1·69	1·80	1·69
	Soda (1)	5·46	0·38	5·24	2·30
	Chloride of sodium (1)	6·82	9·73	8·53	9·21
	Chloride of potassium (1)	6·08	1·50	6·17	2·34
	Sulphuric acid	4·39	6·55	4·01	6·75
	Phosphoric acid	1·28	0·44	1·66	0·32
	Carbonic acid	8·83	6·18	7·42	7·01
	Silica	1·80	0·80	1·00	0·80
	Total	44·87	37·52	45·31	40·75
	Organic matter	11·20	7·80	10·00	7·05
	Total matter in solution	56·07	45·32	55·31	47·80
	Total inorganic matter	91·26	37·52	98·22	40·75
	Total organic matter (2)	51·60	7·80	42·40	7·05
	Total solid matter	142·86	45·32	140·62	47·80
(1) Containing	Potassa	3·84	0·94	3·90	1·48
	Soda	9·07	5·54	9·76	7·17
	Chlorine	7·03	6·61	8·10	6·70
(2) Containing	Ammonia: In suspension	2·92	..	2·42	..
	Ammonia: In solution	5·74	0·98	6·36	0·92
	Ammonia: Total	8·66	0·98	8·78	0·92
	Nitric acid in solution = Ammonia	..	(3) 1·33	..	(4) 1·41

(3) 4·227 Nitric acid = 1·096 Nitrogen = 1·331 Ammonia.
(4) 4·483 ,, = 1·162 ,, = 1·411 ,,

lime, indeed, there was more in a gallon of drainage than of sewage: the like may be said of sulphuric acid. Lastly, of soluble silica a notable portion passed off in the drainage.

Of *organic matter* in solution a very considerable quantity was found in the drainage-water, but of so different a character as to suggest the probability that it was derived from vegetable matter within the soil, rather than directly from the sewage, especially in periods of active vegetation.

It is very important to remark that the drainage contained more *nitrogen* in the form of nitric acid than as ammonia, whereas the sewage scarcely contained an appreciable amount in that form; that is to say, the soil had retained less nitrogen than would have been supposed if only the more partial analyses had been made.

It appears, then, that the constituents of the most value had been most efficiently retained; but nevertheless the sewage had neither been perfectly deprived of its manurial elements nor perfectly purified.

There is, indeed, a limit to the power which a soil possesses of removing substances from solution, or of preventing those already absorbed from being dissolved in water passing through it, the result being dependent on the physical and chemical character of the soil itself, and on the amount and composition of the fluid passing through it.

Where the land is covered with luxuriant vegetation there will probably always be a certain amount of soluble organic matter derived from that source in the drainage-water.

So far, however, as the nitrogen in the drainage exists in the form of nitric acid, it is a pretty satisfactory indication that the organic matter has to a great extent already passed the stage of deleterious putrescence.

The arrangements at Rugby did not allow of the water drained from one portion of the land being passed over another; but at Beddington, near Croydon, a great portion of the water does duty twice and sometimes three times, and it consequently passes from the land in a state of much greater purity than the Rugby drainage-water, as the following Table, framed from results communicated by Mr. Latham (engineer to the Croydon Board of Health), will show. (See following page.)

About the same amount of ammonia was found on the average in the *sewage* of Croydon as in that of Rugby; but in the Croydon *drainage* the amount was extremely small. It is unfortunate that the quantity of nitric acid was not also determined; but we are informed that it undoubtedly exists in some amount in the drainage from the Beddington meadows. Still, although formerly the Croydon Board had to meet numerous law-suits on account of the pollution of the river by the sewage, the fluid is

now so far purified before being discharged, as rather to attract the fish; and those having the right of fishing in the river have found it worth while to fix gratings to prevent their going up the main outfall from the sewage-irrigated land.

TABLE X.—PARTIAL Analyses of the Croydon Sewage before application, of the Drainage-water from the Irrigated Land, and of the River Wandle, above and below the Drainage Outfall from the Irrigated Land.

Grains per Gallon.

CONSTITUENTS.	CROYDON.		RIVER WANDLE.	
	Sewage.	Drainage.	Above Drainage Outfall.	Below Drainage Outfall.
Inorganic matter	48·30	23·40	18·56	20·16
Organic matter	52·20	2·40	1·44	2·08
Total solid matter ..	100·50	25·80	20·00	22·24
Ammonia	6·70	0·21	0·18	0·18

Although further experience is still wanting to determine what amount of sewage can be safely applied to a given area under different conditions of soil, subsoil, &c., there can be no doubt that, when large quantities of sewage are applied to grass-land, the arrangements should be such as to allow of the drainage-water being collected and re-used in such a manner as to insure as far as possible both complete utilisation and complete purification.

EXPERIENCE OF COMMON PRACTICE IN THE UTILISATION OF SEWAGE.

Let us now turn from the results of experimental inquiry to those of practical experience in the utilisation of town sewage. The instance most frequently quoted is that of the neighbourhood of Edinburgh, relating to which some particulars are given in the following Table:—

TABLE XI.—RELATING to the Sewage-irrigated Meadows near Edinburgh.

Names of Meadows.	Imperial Acres under Irrigation.	Approximate Population contributing to each Acre.	Approximate Quantity of Sewage available for each Acre.
			Tons.
Lochend, Spring Gardens, and Craigentinny	285	337	20,500
Roseburn and Western Dalry ..	80	112	17,000
Quarry Holes	8	562	65,000
Broughton Burn	6	1,666	102,000
The Grange	16½	302	97,000

These tabular statements are chiefly based upon direct information, obtained in part from Mr. McPherson, the Edinburgh City Surveyor, and in part from the occupiers or managers of the respective meadows. It should, however, be explained that, as water-closets are not universal, and as the sewage is frequently allowed to pass unused, the record only shows approximately the total amounts available, whether used or wasted.

Sewage has been applied to some portions of the land in the neighbourhood of Edinburgh for about 200 years, to a considerable portion for more than 60, and to most of that now under irrigation for more than 30 years. In two instances arrangements have been made for raising the sewage, by pumping, an inconsiderable number of feet; but the cost has been found too great to allow of a sufficient quantity being applied per acre, and hence the application in this way has been much limited, if not on some portions of the land entirely abandoned. The application is confined to meadow-land and Italian rye-grass, and the distribution is entirely by means of open runs. When Italian rye-grass is grown, the land is periodically broken up, and one or two other crops taken without sewage before laying down again to grass. The application to ordinary rotation crops on arable land forms no part of the system adopted.

There is no doubt that at Edinburgh larger amounts of sewage are applied, and larger amounts of produce obtained per acre than anywhere else. But, on the other hand, there is not only very great waste of manurial constituents, but very imperfect purification of the sewage. Hence their results, however important in some points of view, cannot be relied on as the foundation either of estimates of the practical value of sewage, or of safe conclusions as to the amount of sewage that can advantageously be applied per acre when the drainage has to be passed into a river, which may have to serve as the water-supply of other towns, instead of, as at Edinburgh, having an immediate outfall into the sea.

It may be mentioned that generally four or five crops of grass are obtained per acre annually, amounting, according to circumstances, to 30, 40, 50, 60, and even more tons per imperial acre, and selling for prices varying from 8*l.* to over 40*l.* per acre, but averaging perhaps about 25*l.* These results are in themselves sufficiently striking, and well merit careful inquiry and consideration.

Table XII. summarizes the results of the experience of the most important instances of sewage utilisation in other localities.

TABLE XII.—RELATING to Sewage-irrigation in various localities.

Towns.	Population contributing.	Acres.		Crops, &c.	Annual Payment to Towns.
		Original.	Reduced.		
Alnwick ..	6,500	270	..	Arable and grass; abandoned	Nothing
Carlisle ..	22,000	70	..	Meadow-grass; all grazed ..	?
Croydon ..	16,000	250	..	Meadow and rye-grass	300*l.*
Malvern ..	4,000	50	..	Grass	Nothing
Rugby ..	6,700	190	20	Meadow and rye-grass	50*l.*
		280	100	Meadow; chiefly grazed ..	
Tavistock ..	6,000	95	..	Grass	Nothing
Watford ..	4,000	210	7	Rye-grass—Summer	10*l.*
			35	Meadow-grass—Winter ..	
Worthing ..	7,000	42	..	Grass; not yet at work ..	Nothing

At Alnwick, the late Duke of Northumberland put down machinery and piping for the distribution of the sewage of the town over about 270 acres of mixed arable and grass-land. After a very short time, the tenants, who had the free use of the sewage for the cost of its application, abandoned it altogether; and the Bailiff of the District, who reports the failure, expresses his opinion strongly against the general applicability of sewage to arable land.

At Carlisle, the sewage of only a portion of the town is utilised. It is deodorized by Mr. McDougall's disinfecting fluid, and raised by steam-power some 10 or 12 feet into an open cut, from which it is diverted for application to the land by moveable iron troughs. It is estimated that from 8000 to 9000 tons of sewage are applied per acre per annum. It is understood that little or nothing is realized by the town; but that the tenant makes a considerable profit by sub-letting the sewage-irrigated land for grazing purposes.

In the neighbourhood of Croydon, as already referred to, the sewage of nearly 20,000 persons is applied to about 250 acres of meadow and Italian rye-grass. It is calculated that more than 6000 tons of sewage are available for each acre. A considerable portion of the fluid is used two or three times over; and it finally passes from the land very fairly purified. It is estimated that, after making deduction of 4*l.* for rental, the *gross* return per ton of sewage applied is, at the present prices of the produce, with Italian rye-grass from $\frac{3}{4}d.$ to 1*d.*, and with meadow-grass from $\frac{1}{2}d.$ to $\frac{3}{4}d.$ The sewage is not applied in any systematic manner to other crops, but it has been tried on a small scale to root-crops. An enlargement of the area of irrigation is contemplated, which will, if carried out, reduce the amount of

fluid and excretal matters available per acre somewhat below the quantities above stated.

About 12 years ago, arrangements were made for collecting the sewage of Rugby in a tank, from which it is pumped, by a 12-horse power engine, through iron pipes laid down for the distribution over about 470 acres of mixed arable and grass-land. Up to last year 190 acres were held by Mr. James Archibald Campbell, but he has gradually limited the area of application, and during the last few years has abandoned the use of hose and jet, excepting occasionally on a small scale, and confined the application almost exclusively to from 12 to 20 acres of meadow and Italian rye-grass. The remainder of the land, amounting to about 280 acres, has passed through the hands of two tenants, both of whom are said to have sustained considerable loss. The last of the two had confined the application almost exclusively to about 100 acres of grass-land, and applied the sewage almost entirely by open runs. The whole is now in the hands of the landlord, Mr. G. H. Walker, who, it is understood, is contemplating the abandonment of the use of steam-power, pipes, and hose and jet, and the application to a limited area by means of gravitation.

The general result at Rugby is, then, that after about a dozen years of practical experience, with arrangements adapted for the application of small quantities of sewage per acre to arable as well as to grass-land and to all crops, the area has been greatly limited, the use to any other crops than meadow and Italian rye-grass become quite exceptional, and the application by means of steam-power, pipes, and hose and jet, will probably soon be entirely abandoned. It may be added that, at the time of the experiments of the Commission, the sewage, which was considerably stronger than that of the Metropolis, cost the tenants only about $\frac{3}{4}d.$ per ton at the hydrants in the fields; yet, rather than incur the loss of using it at that cost, both were glad to get rid of it to the Commission, at rates which, though three times as high during the six summer as during the six winter months, averaged the year round scarcely, but very nearly, 1*d.* per ton at the hydrants.

Some years ago, the Earl of Essex laid down pipes for the application of the sewage of Watford, by pumping and hose and jet, to about 210 acres of mixed arable and grass land. The results which his Lordship obtained on the application of only 34 tons [illegible] acre to wheat have frequently been held [illegible] conclusive proof of its applicability in small quantities [illegible] over [illegible] areas, to arable land, and to all crops. But [illegible] the evidence given by his Lordship before the Sewage Com-

mittee of 1862, he stated, very emphatically, that his great error had been the piping of too much land; that he required 5000 tons per acre for 10 acres of rye-grass; and that, applying the remainder to 35 acres of meadow, he had none to spare for wheat. In other words, although the abandonment of one acre of rye-grass would set free sewage enough for nearly 40 acres of wheat, if applied only at the rate which yielded the large gross return per ton of sewage so frequently quoted, yet his Lordship's practical experience had led him to prefer the application to the one acre of rye-grass rather than to the nearly 40 acres of wheat. Further, his Lordship gave it as his opinion that sewage would not be profitable to the farmer unless he could have it at from $\frac{1}{2}$*d.* to $\frac{3}{4}$*d.* per ton.

In reference to the application of sewage to corn crops, it may be stated that, in an experiment made by the Commission at Rugby, with oats, a very high gross money return per ton of sewage was also obtained. The experiment was made in the unusually productive season of 1863, and with sewage of about double the average strength of that of the Metropolis, applied during a period of very dry weather. The results were, therefore, quite exceptional, and cannot be taken as affording any indication of what might be expected from the application of small quantities of sewage to corn crops generally, on different soils, and on the average of seasons. There cannot, indeed, be a doubt, that to obtain a maximum gross value of produce from a given amount of sewage, it should be applied in small quantities per acre, and in dry weather. But sewage is produced in large daily amount at all seasons, and must be disposed of as soon as it is produced. It must, therefore, be applied in winter, when of comparatively little value, as well as in summer, when of more, and it would frequently be quite inapplicable to arable land. Moreover, to obtain an increased gross money-return per ton of sewage by using it on a comprehensive scale for corn and other ordinary rotation crops, would involve the extra cost of main distribution over a ten-fold, if not a twenty-fold area, and require the aid of pipes and hose and jet, instead of open runs.

At Malvern and Tavistock the application of sewage to grass-land has now been carried on for some years, but at Worthing it has only very recently been commenced.

From this short review of the experience of practical men who have undertaken the utilization of sewage with a view to profit, it appears that, wherever arrangements have been made for the application of small quantities over large areas, to corn and other rotation crops on arable land, and by means of pipes and hose and jet, the undertaking has either been entirely

abandoned, or the area greatly limited, and the application confined almost exclusively to meadow and Italian rye-grass. On the other hand, the undertakings which have been the most successful from the agricultural point of view are those in which the arrangements have been adapted for the almost exclusive application to grass, and the application to other crops is only exceptional.

General Practical Conclusions.

The practical conclusions deduced from the whole inquiry may be briefly stated as follows:—

1. It is only by a liberal use of water that the refuse matters of large populations can be removed from their dwellings without nuisance and injury to health.

2. That the discharge of town sewage into rivers renders them unfit as a water supply to other towns, is destructive of their fish, causes deposits which injure their channels, gives rise to emanations which are injurious to health, is a great waste of manurial matter, and should not be permitted.

3. That the proper mode of both utilizing and purifying sewage is to apply it to land.

4. That, considering the great dilution of town sewage, its constant daily supply at all seasons, its greater amount in wet weather when the land can least bear, or least requires more water, and the cost of distribution, it is best fitted for application to grass, which alone can receive it the year round. It may, however, be occasionally applied with advantage to other crops within easy reach of the line or area laid down for the continuous application to grass.

5. That, having regard both to urban and rural interests, an application of about 5000 tons of sewage per acre per annum, to meadow or Italian rye-grass would probably, in the majority of cases, prove t[illegible] rofitable mode of utilization, though the quan[illegible] be reduced, provided experie[illegible] sufficiently purified; and [illegible] would not pay *¾d.*, and it [illegible] uld afford to pay *½d.* per [illegible] the average strength of that [illegible] orm-water) delivered on his land.

[illegible] general application of town [illegible] mous increase in the pro- [illegible] meat; whilst, by the con- [illegible] ge amount [illegible] solid manure, applicable [illegible] generally would be produced.

7. That the cost or profit to a town of arrangements for the removal and utilization of its sewage must vary very greatly, according to its position, and to the character and levels of the land to be irrigated. Where the sewage can be conveyed by gravitation, and a sufficient tract of suitable land is available, the town may realise a profit; but, under contrary conditions, it may have to submit to a pecuniary sacrifice to secure the necessary sanitary advantages.

XI.—*Affections of the Bladder amongst fattening Sheep and Lambs.* By W. E. Litt, M.R.C.V.S.

Prize Essay.

In asking myself, at the outset, "what are the peculiar affections of the bladder amongst fattening sheep and lambs, to which the Royal Agricultural Society wish to call particular attention?" I confess to a feeling of some little difficulty. I have had very considerable experience in the diseases of sheep, and many opportunities of observation, and I know only of *one* such affection. It may be that other parts of the country furnish a different class of maladies to that over which my own practice has ranged—for such things are by no means uncommon amongst domestic animals—and that I have partially mistaken the intended subject. Whether this is so or not, however, is perhaps of little consequence, as the particular disease to which I allude is of sufficient importance to demand the most earnest attention of all who are interested in the pursuits of agriculture.

If the urine of sheep during the process of fattening be subjected to the ordinary simple test of litmus paper, it will generally be found to afford some indications of the presence of an acid. This must be looked upon as altogether an abnormal condition of things, as, under ordinary circumstances, the urine of herbivorous animals will always be found to exhibit an alkaline reaction. The effect of high feeding, therefore, appears to be to assimilate in some measure this particular secretion to that of the carnivora. The *exact* nature and character of the acid in question is a matter which demands a greater amount of consideration at the hands of the chemist than it has hitherto received; but, though differing somewhat in composition, it appears to bear a considerable analogy to that which is known to the physiologist as *uric*, or *lithic* acid, and when it is present in excess, the urine, generally scanty under these circumstances, will always be found to deposit a sediment more or less abundant, and differing somewhat in character and appearance according

to the exact nature of its base. For the most part, however, it may be said to consist of certain of the salts of soda, potass, or lime, with a greater or less admixture of what is known as the ammonia-magnesian phosphate, or triple salt. This peculiar morbid condition of the system is one to which all domestic animals are occasionally liable; but it is so exceedingly common in fattening sheep and lambs, that its special consideration can scarcely fail to be a subject of considerable interest.

The reasons why these sandy or gravelly deposits of the urine are more common and more serious in sheep than in other animals, will be sufficiently apparent when we consider the peculiar circumstances under which fattening sheep and lambs are placed. A high and stimulating system of feeding, with an abundance of saccharine roots, want of exercise, and often a total abstinence from water, are exactly the conditions likely to produce this tendency to lithic sediments in the urine; and the peculiar anatomical construction of the urethra of the sheep is such, that deposits of a character which would pass away readily enough in other animals, soon begin to produce the most serious mischief in him. At the extreme point of the penis is a singular structure known as the "vermiform appendage," so called on account of its worm-like appearance; and the urethral outlet is here so extremely small that the slightest calcareous deposit can with difficulty pass through it. When this lithic acid diathesis, so to speak, then is present, the urethra readily becomes choked up with the sediment, the urine is filtered through it only with the greatest difficulty, coming away merely drop by drop, and accompanied with much straining and other manifestations of pain and suffering. If the obstruction is not speedily got rid of, these symptoms rapidly increase in severity, the bladder becomes inordinately distended, its membranes are inflamed, and great constitutional disturbance necessarily follows. The kidneys in turn participate in the inflammation, the blood becomes thoroughly saturated and poisoned with urine, which may be smelt in all the secretions and tissues of the body, and the animal soon sinks under so serious a complication of diseases. Occasionally, also, rupture of the bladder may be added to the list of evils; but this I have found to be much more rare than might at first sight be expected; when it does take place, however, I need scarcely add that death is the inevitable result.

It will thus be seen that what are commonly spoken of as "affections of the bladder in fattening sheep and lambs," are confined almost exclusively to male animals, that is, to wethers and rams, and in reality are not in the first instance affections of the bladder at all; the bladder is only affected, as it were second-

arily, by the mechanical impediment offered to the evacuation of its contents through the natural channel, and will, *therefore*, require but little of our attention in considering the best means of treatment for the evil in question.

If I am right in the view I have here taken of the true nature of these affections—and I have had very many opportunities of investigating the subject—the treatment to be observed, whether preventive or curative, can scarcely be a matter of controversy. When the disease is found to prevail to any extent amongst a particular flock, attention must be immediately directed to the exciting causes, and these will for the most part be readily enough ascertained. As I have already hinted, the character of the diet, the absence of water, and the want of exercise, are the most probable causes. It is not easy, perhaps, to specify at all times the exact article of diet most in fault. Often, doubtless, it is rather a combination of several ingredients, than any one in particular, to which the mischief is attributable; but, as far as my own observation goes, I am inclined to think that *the saccharine roots, and particularly mangold-wurzel, are especially injurious*, although it must be borne in mind that those articles of food in which starch is abundantly found, such, for example, as barley, wheat, and the like, are equally productive, under particular circumstances, of these sabulous deposits. *So far as is practicable, therefore, the preventive treatment must always be initiated by such an alteration of the diet as will exclude those articles which abound largely in saccharine and starchy matters, and an allowance of moderate exercise and free access to water will do the rest.* The effect of a regimen like this is most marked, and I have had many opportunities of observing and approving its beneficial results.

The curative treatment of the disease is a more serious and difficult matter. Generally, it is true, when we are dealing with wethers alone, the most economical plan is to hand over the affected animal to the butcher at once, and to endeavour to arrest the further extension of the malady by the simple preventive means to which I have just pointed. Cases will often arise, however, where it is desirable to prolong the animal's life, and most especially is this the case in highly-bred rams, in which I have found the disease to be particularly fatal. As these animals often possess a value far, very far beyond what the butcher would give for them, their treatment is just as much a matter of interest and consideration to the farmer as that of either his horses or his cattle, and it is desirable, therefore, that I should enter somewhat at length into this most important division of the subject.

An observant shepherd will first be made aware of the

presence of the affection in question by the usual symptoms of disease. The animal is dull and more or less off his feed, holding himself aloof from his fellows, and generally lying down. When roused or lifted up, the peculiar nature of his malady will become manifest at once by the painful efforts made to pass his urine. His breathing is quickened, and he strains almost constantly, whilst only a few drops are observed to come away. If the patient be now turned up on his rump, and the penis drawn out, it will generally be found that the urethra, or at least that portion of it comprised in the vermiform appendage, is choked up with the sediment of which I have already spoken. This sediment differs considerably in its character, varying from the appearance of very fine gravel to that of the finest sand. Until this is removed, it will be seen at once that there is little to be done in the way of remedy; and the urethral termination is so very small that to remove it is often a matter of much difficulty. When of the consistence of fine sand, however, a little patient manipulation will often be crowned with the required success. As there is commonly some local inflammation of the neighbouring parts, it is always advisable to commence proceedings by fomentation with warm water; afterwards gently pressing the urethra so as to force out the accumulated deposit. Having succeeded either wholly or partially in this, a little sweet oil may then be applied to the parts, and a dose of opening medicine administered. Either castor-oil or fine linseed-oil—in doses of 2 to 6 ounces according to the size and strength of the patient—are preferable to the ordinary saline aperients; and where much constitutional disturbance is present, I always add to this dose from 8 to 16 grains of the extract of belladonna. On the following day the urethra must be again examined, and, if necessary, the proceeding already described may be repeated, the medicinal treatment being now made to consist of the free exhibition of some of the alkaline carbonates, and the best is, unquestionably, the carbonate of potass, as the salts of potass are for the most part perfectly soluble, and will readily pass off dissolved in the urine. Carbonate of potass may then be given in doses of half a dram to a dram, two or three times a day, dissolved in water, either alone, or in combination with the belladonna or other febrifuge medicines, as may be found necessary. And here I would remark that, without proper regard to regimen, no treatment will be of much avail. Air exercise, proper diet, and the free use of water, are of the utmost importance. Physicians tell us that the lithates are sometimes thrown down, not from undue acidity of the urine, but simply from that fluid not containing the due quantity of water to hold them in solution, and that in such cases a tumbler

of cold spring water, taken night and morning, will at once cause the cessation of this morbid symptom. This fact is important, and though too much reliance must not be placed on analogy with human medicine, I am satisfied, from practical observations, that water is a most valuable adjunct to other treatment in the removal of the disease in question, and where sheep refuse to drink it voluntarily their medicine should always be largely diluted with it.

It is not always, however, that the removal of the sediment from the urethra can be so easily effected. On the contrary, it will frequently be found of such a character (gritty, and of the size of small seeds) that it cannot possibly be passed through the external opening. In such cases I have never hesitated to make an incision on the under surface of the urethra, as near the extremity as possible, generally, indeed, in the vermiform appendage itself, large enough to allow this gravel to be pressed out. Sometimes, indeed, the simplest and most desirable mode of proceeding is to remove this structure altogether. In wethers there cannot be the slightest objection to so simple an operation at any time; but in rams the case is somewhat different. It is generally believed that this peculiar appendage is intended by nature to perform some important function in the act of copulation, and that where it has been removed the ram is no longer capable of procreation. I am not fully prepared, at the present moment, either to endorse or contradict this opinion; but I am assured by a distinguished sheep-breeder in this district, that the commonly received opinion on this subject is an erroneous one, and that he has had many lambs got by rams which had undergone the mutilation in question. At all events, the matter appears to be so far one of grave doubt that it is much to be desired that satisfactory experiments should be instituted with a view to settling the question. Be this as it may, however, I am satisfied that a longitudinal incision, such as I have just described, may be made into the organ without in any way impairing its supposed functions, and there need not, therefore, be any reason to hesitate in such a course of proceeding when the circumstances of the case appear to render it necessary. By such means, with frequent fomentations and careful manipulation, the obstruction may often be removed; and a proper observance of the medicinal treatment already pointed out will complete the cure. It is only just to add, also, that cases will occasionally be met with in which these accumulations are so abundant, occupying not only the urethra, but also the bladder, ureters, and even the kidney itself, that no treatment can be of any service. Such cases may always be distinguished by observing that little or no relief follows the removal of the deposit from the penal portion of the urethra, and from

the greater amount of constitutional disturbance which marks their progress. Once satisfied that the extent of the mischief is such as to preclude all hope of remedy, the flockmaster must have recourse to the butcher's knife as soon as possible, as the whole system now rapidly becomes so thoroughly impregnated with urine, that the meat is no longer wholesome as food.

Such is the brief history of a disease which has of late years prevailed very largely in this part of the country, and has therefore come frequently under my observation. I have taken considerable interest in the subject, and given some attention to the causes, nature, and treatment of the malady; and these remarks are simply the practical conclusions and deductions at which I have arrived. It would have been easy for me to have extended and amplified the views here expressed, but I have preferred to be as concise and practical as possible, believing that I should thus be better understood and appreciated by those who have the deepest interest in this matter. Such is unquestionably the particular object of these papers, and I confess I am not without hope, therefore, that the sheep-farmer may find something of value and importance in what I have here written.

Shrewsbury.

XII.—*Field Experiments on Root-Crops.* By Dr. Augustus Voelcker.

General ideas respecting the properties of manures, the chemical and physical character of fertile and sterile soils, the requirements of plants, and the composition and uses of our crops, no doubt are useful in awakening and sustaining a spirit of inquiry amongst agriculturists. But, in addition to a sound knowledge of the rudiments of chemistry and physiology, a man must be acquainted with special facts before he can turn to profitable account any chemical or physiological knowledge which he may possess.

It is no doubt useful to any person who is in the habit of spending money in purchased manures, to know the composition of genuine and adulterated guano, or that of good and bad superphosphates; for such knowledge will guard him against imposition, and enable him to buy the manures he requires of the best quality, and at a reasonable price. It is not enough, however, for him to be acquainted with the composition of the various artificial manures now sold in the market, if he wishes to apply his chemical knowledge to the best advantage. In order that he may do this, he must likewise know how, when, and in what quantities, guano, or superphosphate, or nitrate of soda,

etc., should be used; for what crops these fertilizers are more specially useful, and how the variable agricultural condition and chemical composition of our fields affects, practically, the efficiency of artifical manures. In short, the rational and profitable application of artificial manures necessitates a much more extended and special practical experience than a person need have who never uses any other than common farmyard-manure. A certain amount of chemical knowledge is thus indispensable to the modern farmer who wishes profitably to employ artificial manures on his land.

Whilst no rational man will consider chemical knowledge in itself a substitute for the experience in the routine of farm work which a person must possess who farms for profit, it will be readily conceded that the rudiments of chemistry are very useful, if not indispensable, for the acquisition of a greater amount of practical experience than was required at a time when guano, bones, &c., were unknown to the agricultural world.

Agricultural chemistry, useful as it is to the improving tenant farmer of the present day, is doubly valuable to persons willing to undertake field experiments with special manures. Systematic scientific instruction, such as is given, for instance, at Cirencester College, if it confers not that direct advantage upon the young farmers which some over-sanguine men anticipated, is calculated to improve wonderfully the powers of observation, so as to enable those who have enjoyed the benefit of a liberal education to perform agricultural experiments with that amount of precision and foresight which cannot reasonably be expected from others.

Many of my farming friends, with much good will, are always ready to begin any experiment which I may suggest to them; but the difficulty I experience is that men totally unacquainted with the teachings of science are unable to surmount the unforeseen difficulties that present themselves in all experimental inquiries; consequently, many begin well, but never bring their effort to a successful issue. It affords me, therefore, particular pleasure to mention that, four years since, I succeeded in engaging the co-operation of a number of intelligent men, for the greater part former pupils of mine, in performing systematic field experiments.

On a former occasion, I published the results of field experiments on clover-seeds, and also a short paper on the effect of potash-salts and common salt on mangolds. I have now the pleasure of laying before the Society short reports on similar experiments on swedes, mangolds, and potatoes, which were carried out under my direction in the years 1864, 1865, and 1866. According to a pre-arranged plan, the same artificial

manures were sent to about a dozen men residing in different counties; but their returns, I regret to say, in the great majority of instances recorded either complete failures, mainly due to the remarkable drought in the spring and early summer months of 1864 and 1865, or results void of all practical interest, from which no general principles could fairly be deduced. Desiring not to burden the reader with an account of these failures, I have selected for publication only such experiments as appeared to me to embody points of agricultural interest.

Experiments on Swedes in 1864.

The object of the following experiments was to ascertain whether the artificial supply of potash is characterised by any marked effect upon root-crops. Simple as this enquiry may appear at first sight, it is nevertheless beset with many difficulties, which have to be kept steadily in view in devising a plan of field experiments for its investigation. In the first place, experience has shown already that most soils in a fair agricultural condition neither require nor are in the least benefited by the exclusive supply of potash. Good clay soils, as a rule, contain abundant stores of potash to meet the wants of root-crops. On sandy soils, which are naturally deficient in that element, we meet at once with another difficulty, from the fact that other constituents entering largely into the composition of root-crops are generally but scantily represented; and, for this reason, it cannot be expected that the application to such land of a manure which supplies only one essential plant-constituent will be attended with any marked effect. In devising a plan of field experiments care should be taken to make provision for any disturbing influences arising from the chemical nature of the experimental field, and the requirements of the crops under experiment.

The cheapest form in which potash can be put on the land is that of crude German potash-salts. A sample of these salts, which were employed in all the following experiments, on analysis was found to contain in 100 parts,—

Moisture	11·63
Organic matter	·73
Oxide of iron	·34
Sulphate of potash	24·03
Sulphate of magnesia	1·14
Chloride of magnesium	12·01
Chloride of sodium (common salt)	47·85
Sulphate of lime	·78
Magnesia	·52
Sand	·97
	100·00

The chloride of sodium (common salt), which enters so largely into the composition of these salts, has in itself a decidedly beneficial effect upon root-crops grown on light sandy soils; it is therefore further necessary to eliminate, if possible, the effects likely to be produced by its action. To this end one portion of the experimental field was manured with common salt, and another portion with crude German potash-salts. After a good deal of consideration, I laid down the following scheme, having special reference to light soils:—

No.
1. Farmyard-manure, at the rate of 20 tons per acre.
2. Farmyard-manure, at the rate of 10 tons per acre, and 4 cwts. of dissolved bone-ash.
3. Dissolved bone-ash, at the rate of 4 cwts. per acre.
4. Unmanured.
5. Crude potash-salts, at the rate of 4 cwts. per acre.
6. Common salt, at the rate of 4 cwts. per acre.
7. Dissolved bone-ash, at the rate of 4 cwts., and crude potash-salts, at the rate of 4 cwts. per acre.
8. Dissolved bone-ash and common salt, each at the rate of 4 cwts. per acre.

Each experimental plot was exactly one-twentieth of an acre.

For root-crops this is a convenient and sufficiently large piece of ground for each experiment. Smaller plots I do not recommend, and patches of land measuring only the 100th part of an acre or less, in my opinion, are decidedly objectionable for field trials upon roots.

It is to be regretted that in the preceding scheme only one plot was left unmanured. In more recent field trials three plots are left without any manure; in this way an insight is obtained into the variations of the natural productive powers of different parts of the experimental field. The unmanured plots are best placed one right in the middle, and two at the ends of the experimental field.

It will hardly be necessary to remind the reader that farmyard-manure contains all the mineral elements which are found in the ashes of swedes, and besides these mineral constituents, supplies ammoniacal salts, nitrogenous and carbonaceous matters to the land.

Good farmyard-manure, that is to say, manure in which the urine of animals and the soluble matters of the excrements have been well preserved from being washed out by rain, &c., contains about a half per cent. of potash. The dressing of 20 tons per acre thus added to the land considerably more potash than the crude German potash, which contained only 24 per cent. of sulphate of potash. Even half that dressing of yard-manure, which in No. 2 was applied to the land in conjunction with

superphosphate of lime, contained more potash than the German salts on plot No. 5. 20 tons of dung is a heavy dressing per acre, and probably more than is enough to meet the requirements of the swede crop on the poorest soil.

On some land such a heavy dose of dung, I have reason to say, might do harm to the roots, or, at any rate, not so much good as a more moderate manuring. On light land, however, like that on which the experiments were tried, no fear need be entertained that root-crops will be injured by too much manure. Still I thought it advisable to ascertain whether so large a dose of dung might have been too much for the roots, and therefore used on plot 2 only half the quantity of dung in conjunction with superphosphate.

In field experiments with special manures it is desirable to set aside at least two plots for trying the effects of a full and of a half dressing of good farmyard-manure. By comparing the produce of the unmanured plots with that of the plots dressed with a perfect manure like dung, a good idea of the agricultural condition of the land under trial may be obtained, the results showing to what extent its productive powers may be readily enhanced by particular manures.

In previous experiments upon root-crops, I found the application of purely mineral superphosphates more useful to roots than other more complex artifical manures. This I found especially to be the case when the land had been liberally treated before, and was in good heart. On naturally poor soils, or land out of condition, on the other hand, the addition of a moderate proportion of ammonia, say 2½ to 3 per cent., as well as of some common salt (5 to 8 per cent.) to a turnip-manure composed mainly of dissolved bone-material was attended with good success.

In the experiments before us this has been kept in view. One of the experimental plots, it will be seen, was manured with a purely mineral superphosphate, another with a mixture of the same superphosphate and crude potash-salts, and a third with mineral superphosphate and salt.

Trials with the crude German salts may be useful as a kind of confirmatory test, but neither their success nor their failure is conclusive. The success may be due to the common salt which they contain, as experience has shown that on light soils a moderate dressing of salt, in some seasons, gives a considerable increase. The non-efficacy of the crude potash-salts, on the other hand, does not clearly prove that it is superfluous to apply potash, for the soil may be in a high state of cultivation and contain abundant stores of plant food, or it may

be so poor in elements of fertility other than potash, that the latter, for this very reason, has not a fair chance to exercise a beneficial influence.

These remarks will suffice to show how many obstacles have to be overcome in attempts to solve experimentally an apparently simple problem, and afford an insight into the reason which induced me to try the German salts side by side with common salt, superphosphate, farmyard-manure, and mixtures of superphosphate with salt and potash.

My friend, Mr. Jacob Wilson, of Woodhorn Manor, Morpeth, kindly undertook to carry out the experiments, as stated above, on light but good sandy loam.

The results he obtained are calculated in the following table to the acre :—

AMOUNT of SWEDES, ROOTS, and TOPS per Acre, grown at WOODHORN MANOR, MORPETH, 1864.

No.	Per Acre.	Roots.				Tops.			
		tons.	cwts.	stones.	lbs.	tons.	cwts.	stones.	lbs.
1	Farmyard-manure 20 tons	22	3	6	5	2	8	6	1
2	Farmyard-manure 10 tons, and dissolved bone-ash 4 cwts.	19	15	9	2	2	16	0	8
3	Dissolved bone-ash 4 cwts.	23	1	8	5	2	1	3	8
4	No manure	17	18	3	8	2	1	3	8
5	Crude German potash-salts 4 cwts. ..	22	3	6	5	2	6	2	8
6	Common salt 4 cwts.	15	14	4	6	2	3	7	0
7	Dissolved bone-ash 4 cwts., and crude potash-salts 4 cwts...	22	3	6	5	2	11	1	8
8	Dissolved bone-ash 4 cwts., and common salt 4 cwts.	20	4	6	2	2	6	2	8

The preceding tabulated results exhibit some points of interest and a few curious anomalies.

1. In the first place, it will be seen that the unmanured portion of the experimental field produced a very fair crop of swedes. We may therefore infer that the land was in a good agricultural condition.

2. Notwithstanding its good condition, 4 cwts. of a purely mineral superphosphate gave an increase of rather more than 5 tons of roots per acre. This is the largest increase which was obtained from any of the plots, not excepting the one manured with 20 tons of dung per acre. Having found repeatedly in other experiments that on land in a high state of cultivation mineral superphosphate, rich in soluble phosphate of lime, produced a better root-crop than a heavy dressing of dung, this result did not surprise me.

3. It is difficult, however, to understand why the addition of superphosphate to half the quantity of dung, which was placed on plot 1, should reduce the crop as much as it did. There can be no doubt about the accuracy of the result, and it is therefore placed on record as an example of the curious and unexceptionable anomalies which so frequently puzzle the experimenting agriculturist.

4. The crude potash-salts on plot 5, it will be seen, had a very good effect, for they gave an increase of 3 tons 5 cwts. of roots per acre.

5. Exactly the same increase was obtained when the potash salts were mixed with superphosphate. The addition of the latter, one would have thought, should increase the produce beyond what the salts used alone gave, but the result was otherwise. It appears, however, that superphosphate, when combined with *any* of the other manures, produced a remarkable increase in the weight of the tops, which may have been prejudicial to the development of the bulbs, the amount of available soluble fertilising matters in the mixture of dung and superphosphate, and in the mixture of potash-salts and superphosphate being excessive, and causing the roots to run too much to top. I have noticed before that soluble saline matters had this effect, though not in all seasons; and it appears to me, therefore, advisable to apply readily soluble fertilising matters in moderate quantities to root-crops.

6. Common salt appears to have done rather harm than good in these experiments, for the salted plot gave 2 tons 3 cwts. 7 stones and 2lbs. less swedes than the portion of the field which received no manure whatever.

7. The addition of superphosphate to common salt had a much better effect than salt alone, but the increase in the crop was not equal to that obtained by potash salts and superphosphate.

Crude German potash-salts applied alone or in conjunction with superphosphate, had a decidedly better effect than common salt. The large increase produced by the German salts alone certainly speaks favourably for the use of potash manures for roots grown on light land, and encourages further trials on such land.

Experiments on Swedes in 1865.

The same plan of manuring as that laid down for 1864 was again adopted in 1865. The summer, however, was, if anything, even more unfavourable for the cultivation of root-crops than that of the preceding year. The results then obtained cannot

therefore be relied upon as a good general guide; indeed, my swede experiments turned out more or less complete failures; I therefore give only one series, that tried by my friend Mr. Robert Vallentine, near Leighton Buzzard, on a light sandy soil, as an illustration of the difficulties with which the field experimenter has to contend, and on account of the useful practical remarks which accompanied Mr. Vallentine's report:—

"EXPERIMENTS with ARTIFICIAL and FARMYARD-MANURES at BURCOTT LODGE FARM, BUCKS.

Plots $\frac{1}{20}$ of an Acre each.

No.		Produce.		Per Acre.		Number of Roots per Plot.
		cwts.	qrs.	tons.	cwts.	
1	Farmyard-manure 1 ton	13	1	13	5	1077
2	Farmyard-manure ½ ton .. .. .. Mineral superphosphate 22½ lbs.*	14	0	14	0	1200
3	Mineral superphosphate 22½ lbs.	11	2	11	10	1240
4	Nothing	10	0	10	0	1150
5	Crude salts of potash 22½ lbs.	11	1	11	5	1250
6	Common salt 22½ lbs.	13	2	13	10	1220
7	Mineral superphosphate 22½ lbs. .. .. Crude salts of potash 22½ lbs.	14	0	14	0	1300
8	Mineral superphosphate 22½ lbs. .. .. Common salt 22½ lbs.	13	0	13	0	1290

"The experiments were tried in the middle of a field of light sandy loam, to which no farmyard-manure had been applied for fourteen years. Each plot contained 3 rows of about 5 chains in length. Ridges were first formed, and then rolled down, so that the manure might not be placed too deep. The land was ridged, the manure and seed sown within the space of two hours, on the 17th of May, with Sutton's Swede; elevation of field above the sea-level about 500 feet. The ground was moist when the seed was sown, and was rolled down almost immediately. No rain fell till nearly a fortnight afterwards, when, although the quantity was considerable, it fell so rapidly that a very large proportion ran off the land by the channels between the ridges which were formed down hill. After this there were but slight showers before the period of protracted drought set in, by which time all the turnips began to suffer from mildew, from which the crop never recovered. The crop was singled on June 30, when the plants were large. The most forward plants, when singled, were those after superphosphate alone, mixed superphosphate and crude potash, and nothing; the potash and com-

* Equivalent to 4 cwts. per acre.

mon salt lots most backward. Crop raised, and trimmed tops and roots on Oct. 11th.

"The farmyard-manure applied was of a very inferior kind, little more than wet straw, all the best manure having been previously taken to other fields. Owing to the dry weather this seemed to admit the drought into the land, and lessen the plant. The weather was also undoubtedly much too dry for the saline manures, although it appears strange that common salt alone produced a heavier crop than dung and several other lots. It is but right to state that one of the three rows devoted to the salt-experiment was missed in sowing the seed the first time, and was then sown a fortnight later than the other lots. Owing to the very dry weather, and the overshadowing power of the rows on either side, the late row was kept back: indeed it was not half as good as the general average; it was therefore not included in estimating the weight of the plot. The exclusion of this row, lest it might mislead, may however have led to error on the other hand, as the comparatively vacant space left by the late row allowed the others on each side to grow more freely. Out of all the root-crops sown, amounting to nearly 50 acres there was not a yard missed, except in this one experimental plot. This defect is to be regretted; but in so peculiar a season it would in no case be advisable to attach much importance to any of the experiments.

"On each side of the experimental plots bone-superphosphate was used as a manure for the general crop, which produced 16 tons per acre on one part, and on another part, some distance off, 22 tons per acre; this was ascertained from a much larger extent of ground than the experimental plots. Strange to say, that part which grew the 22 tons per acre had never borne a good crop of either roots or corn until both lime and salt were applied about three years ago. Whether the soil was really deficient of lime or salt, or whether it was so filled with insects that plants could not thrive, there is no evidence at present to show."

Mr. Vallentine's remarks will be read with interest; they have forcibly convinced me of the advantage which individuals would gain by trying their hands at field experiments, and recording faithfully any general observations which they may have an opportunity of making in their ordinary course of farm practice.

Experiments on Mangolds in 1865.

The same fertilizers which were employed in the preceding experiments were tried upon a red cool clay soil by Mr. H. John Charlton, of Henfields, Bewdley, with the following results:—

MANGOLD EXPERIMENTS AT HENFIELD, BEWDLEY.

Plots $\frac{1}{20}$ of an Acre.	Manure per $\frac{1}{20}$ of an Acre.	Produce per $\frac{1}{20}$ of an Acre.			Produce per Acre.	
		tons.	cwts.	lbs.	tons.	cwts.
1	Farmyard-manure 1 ton	1	7	28	27	5
2	Farmyard-manure ½ ton, and dissolved bone-ash 22½ lbs.*	1	6	28	26	5
3	Dissolved bone-ash 22½ lbs.	1	6	0	26	0
4	No manure	0	14	28	14	5
5	Crude German potash-salts 22½ lbs.	0	16	0	16	0
6	Common salt 22½ lbs.	1	0	0	20	0
7	Dissolved bone-ash and crude potash-salts each 22½ lbs.	1	12	0	32	0
8	Dissolved bone-ash and common salt each 22½ lbs.	1	9	0	29	0

The manures and seed were sown towards the end of April. The highest produce was not equal to that of 2½ acres of adjoining mangolds, which were manured with 16 tons of farmyard-manure and 4 cwts. of Proctor and Ryland's mangold manure, viz. nearly 35 tons per acre.

It appears in these experiments:—

1. That crude potash-salts applied alone gave an increase of not quite 2 tons per acre.

2. That salt alone had a better effect than crude potash-salts.

3. That the mixture of potash-salts and superphosphate produced the largest increase of any of the experimental plots, amounting to 17 tons 15 cwts., and more than doubling the yield of the unmanured portion of the field.

4. That the addition of common salt to superphosphate had likewise a very good effect, but fell short by 3 tons per acre of the effect from potash-salts and superphosphate.

On the whole, the application of crude potash-salts was successful, and it is worthy of notice that their mixture with superphosphate produced a considerably heavier yield than a large dressing of dung. The same mixture, according to my experience, is very useful upon clover seeds, as will be seen by a reference to my paper on clover experiments in last year's Journal.

FIELD EXPERIMENTS ON ROOTS IN 1866.

The experiments which I have to report for 1866 were made on the farms of Mr. James Kimber, Mr. Robert Vallentine, and Mr. W. H. Hetherington.

Mr. Kimber tried the crude potash-salts in two series of experi-

* Equivalent to 4 cwts. per acre.

ments on swedes; Mr. Vallentine on swedes, mangolds, and potatoes; and Mr. Hetherington on potatoes.

Experiments on Swedes at Mr. Kimber's Farm, Tubney Warren, Abingdon, in 1866.—The trial-field, a poor sandy soil, was cropped in 1862 with wheat, top-dressed with nitrate of soda after clover; in 1863, it grew swedes with dung and superphosphate; in 1864 barley; and in 1865, peas without manure. No dung or artificials, except those mentioned in the experiments, were applied to the land after the pea-crop.

The soil, as will be seen by the subjoined analysis, was such that potash might be supposed to have a good chance of exerting a beneficial influence on swedes:—

This soil contained in 100 parts:—

Moisture (when analysed)	·82
Organic matter and water of combination	2·45
Oxides of iron and alumina	3·13
Lime	·14
Phosphoric acid	·04
Sulphuric acid	·19
Magnesia and alkalies	·47
Carbonic acid	traces
Insoluble silicious matter (sand)	92·99
	100·23

The potash-salts and common salt were applied to the land broadcast before the seed was drilled, and the superphosphate and seed were drilled on the 26th of June.

The crop, being a late one, was left on the land until the 27th of December, when the roots were taken up, cleaned, and weighed. The following results were obtained:—

PRODUCE in CLEAN SWEDES of SEVEN EXPERIMENTAL PLOTS of $\frac{1}{20}$ of an Acre each, at TUBNEY WARREN, ABINGDON.

Plots.	Manure.	Quantity of Manure per Acre.	Produce per Acre.			Increase or Decrease.		
		cwts.	tons.	cwts.	lbs.	tons.	cwts.	lbs.
1	Superphosphate	3	8	3	64	5	3	96
2	Superphosphate and Common salt	3 3	9	4	32	6	3	64
3	Superphosphate and Crude potash-salts	3 3	9	17	96	6	17	16
4	No manure	..	3	0	80			
5	Common salt	3	2	8	84	0	11	108 (decrease)
6	Crude potash-salts	3	3	14	12	0	13	44
7	Superphosphate	3	9	19	12	6	18	44

We learn from the preceding experiments that whilst superphosphate alone doubled the produce, crude potash-salts alone gave no appreciable increase. The addition of these salts to superphosphate increased as little the efficacy of the phosphatic manures as that of common salt. This possibly may be a case in point, of the potash failing because the soil was poor in elements of fertility other than potash, as stated in page 505.

The roots on the plot dressed with salt weighed about 12 cwts. less per acre than those grown on the unmanured part of the field. This difference, however, falls within the range of the natural variations in the productive powers of adjoining strips of the same field. Indeed, the difference in the produce of plots 1 and 7, both manured with 3 cwts. of superphosphate, is much greater than the decrease on plot 5.

The want of success here experienced with potash-salts and common salt is the more surprising, since common salts applied to mangolds grown on the same land in previous years considerably increased that crop. It may have arisen in part from the late date at which the swedes were sown, or yet more from the circumstance that the saline manures were sown broadcast just before drilling the seed, for Mr. Kimber informs me that they visibly checked the growth of the young plants. Where no superphosphate was applied, the young plants never got a fair start; where it alone was applied, the crop was as good, if not better than where the addition of potash-salts or common salt was made.

Since saline matters certainly check the growth of the turnip plant in its earliest stages of existence, even on land on which such manures might be beneficial, if applied under more favourable conditions, two courses are open to us in their use:—either to make the application quite early in spring, say towards the end of February, or to delay it until the plants are singled, in a vigorously growing condition. The early application of salt will secure its general diffusion through a large mass of soil; but, on the other hand, if the early spring months should be very wet, most of the salt undoubtedly would be washed away, for though all soils have the power, some in smaller, others in greater degree, to absorb and retain potash, ammonia, or phosphoric acid from soluble fertilising matters, they do not exert such a power on soda-salts, and allow consequently common salt to pass away with the drainage water.

If the application of salt to root-crops be delayed until the plants are singled and in a vigorous state of growth, and little or no rain falls afterwards, the roots certainly will not be benefited by the salt; nevertheless, on the average of seasons I am inclined to think it the better plan to sow the salt broad-

cast between the drills when the plants are strong, say about the second hoeing.

Mr. Kimber tried another set of experiments with swedes on a field which, in 1865, grew wheat, with dung; was again dunged and planted in the autumn with green rye, which was fed off by sheep in the spring of 1866; the land was then worked, and the swedes drilled with 3 cwts. of superphosphate. After the swedes were singled out, and strong, a portion of the most uniform part of the field was divided into six plots of 1-20th of an acre each. To two of these plots crude potash-salts were applied on the 26th of July, to two common salt, and two plots were left without any saline manure.

The following results were obtained:—

EXPERIMENTS on SWEDES, after GREEN-RYE, made at TUBNEY WARREN, ABINGDON, 1866.

(All the Experimental Plots were manured with Superphosphate, at the rate of 3 cwts. per Acre.)

Plots.	Auxiliary Dressing.	Quantity per Acre.	Produce per Acre.			Increase over Average of Nothing Plots.		
		cwts.	tons.	cwts.	lbs.	tons.	cwts.	lbs.
1	Crude potash-salts	3	12	16	28	0	11	58
2	None	..	11	19	32		..	
3	Common salt	3	13	4	32	0	19	62
4	Crude potash-salts	3	12	10	20	0	5	50
						(Average of 2 and 5.)		
5	None	..	12	10	20	12	4	82
6	Common salt	3	13	17	76	1	12	106

Taking into consideration the natural variations of the productive powers of the same field, we are forced to confess that in these experiments neither salt nor potash-salts increased the efficacy of the superphosphate results.

Experiments with Crude German Potash-Salts at Burcott Lodge Farm (1866) *on Mangolds.*—The soil of the experimental field was a clay loam, which furnished, on analysis, the following results, after drying at 212° Fahr.:—

Composition of Experimental Mangold Field.

Organic matter and water of combination	4·49
Oxides of iron	8·08
Alumina	2·98
Phosphoric acid	·24
Sulphuric acid	·19
Carbonate of lime	1·19
Alcalies and magnesia	1·68
Insoluble silicious matter (chiefly clay)	81·15
	100·00

The field was in a good agricultural condition.

With a view of testing the merits of these salts as an auxiliary manure for mangolds, a portion of a field was dressed with them on the 28th of February, at the rate of 4 cwts. per acre. The whole field was manured on May 12th with 15 tons of dung and 2½ cwts. of bone superphosphate in ridges. The mangold-seed was drilled on the same day. The soil was damp, and the seed on the potash plot germinated well, and came to a plant at the same time as on the land on either side. The young plants were singled out on July 2nd, 18 inches between plant and plant, and 28 inches between the rows. Soon after the young mangolds were singled, the leaves became slightly yellow. This appearance continued, and even increased, throughout the summer and autumn, until the crop was pulled up on November 8th. On the most clayey ground the potash mangolds suffered much in unhealthy scorched-looking leaves.

The plants (750) on the potash plot (1-20th of an acre) were more numerous than where no potash was applied. This was caused by the accident of growth and singling out, and not by design. On another plot of 1-20th of an acre only 660 mangolds were found. The produce in cleaned and trimmed mangolds per acre was:—without potash-salt, 21 tons; with 4 cwts. of potash-salts per acre, 20 tons 3 cwts. 18 lbs. The 750 mangold-bulbs grown with potash-salts averaged scarcely 3 lbs. each, the 660 above 3 lbs. each. There were some few rather large blanks on the non-potash part, and Mr. Vallentine estimated that about three tons more mangolds would have been grown there had the plant been equally good.

Last summer was rather too wet, and not hot enough for mangolds; this makes it appear that on clay soils in a good agricultural condition, the addition of potash-salts, and probably other readily soluble saline matters, to a good dressing of dung and superphosphate does more harm than good to mangolds. The yellow colour of the potash mangolds, and marked appearance of their leaves, evidently shows that the land contained too great an abundance of soluble saline matters.

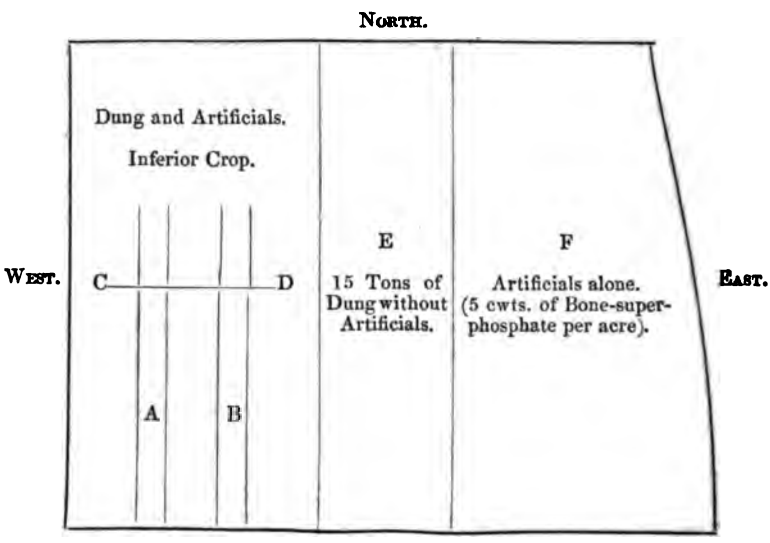
Experiments with Crude Potash-Salts on Swedish Turnips, at Burcott Lodge, Leighton Buzzard, 1866.—Crude German potash-salts were applied at the rate of 4 cwts. per acre, on February 28th, 1866, when the ground was in a fine state of winter preparation, having been twice ploughed, and deeply stirred when dry. The swede field was very similar in character to the mangold field, but not quite so clayey; it contained but little lime.

Composition of the Experimental Swede Field.

	Soil dried at 212° Fahr.
Organic matter and water of combination	6·16
Oxide of iron	7·91
Alumina	2·61
Phosphoric acid	·17
Sulphuric acid	·16
Carbonate of lime	·51
Alcalies and magnesia	1·61
Insoluble silicious matter (chiefly clay)	80·87
	100·00

The character of the field, which measured 18 acres, varied a good deal in different parts, and some difficulty was experienced in finding a uniform and level piece on which the experiments could be tried. The following sketch will render more intelligible the remarks which Mr. Vallentine sent me with his report:—

SKETCH OF EXPERIMENTAL SWEDE FIELD—18 Acres.



45 lbs. of crude potash-salts were applied on February 28th to he space marked A, which measured 80 yards in length and in breadth, or 1-10th of an acre. A space 3 yards wide, and yards long, was taken in the middle of the piece as 1-20th of u acre, for ascertaining the weight of the crop, which was

taken up on the 24th of November. The weight of clean roots was:—

At A, with potash-salts, 10½ cwts., or 10 tons 10 cwts. per acre.
At B, without potash, 9 cwts., or 9 tons per acre.

There was thus an increase of 30 cwts. per acre in favour of the potash-salts. It is, however, proper to state that the ground upon which the experiments were tried was very much injured during the course of preparation by drenching rains, which fell again and again at night, after it had been ploughed, and also after it had been scarified; there was, however, no alternative but to sow the crop when the weather became dry, and make the experiments under very unfavourable circumstances.

The space above the line C D is a stiff clay, and here the crop failed particularly.

About 7 acres on the west side of the field was also very much injured by frequent rains happening to fall during the working of the land, and this, and this alone, appears to have spoiled the crop, irrespective of any particular system of manuring. On this space, 7 acres, about 15 tons of good rotten dung, and 2½ cwts. of bone superphosphate were used per acre; the average weight of the crop was under 10 tons per acre, whilst the space marked E received dung alone, and produced fully double the weight of roots per acre, in consequence of the land having been worked during finer weather, and having been in excellent order when the seed was sown.

The space F was also in a fine state of preparation, and produced as much again as the 7-acre piece, although it had only a dressing of 5 cwts. of bone superphosphate per acre.

The spaces A, B, C, D were first sown (May 22nd), and could not be hoed for nearly a month. E and F were sown on the 29th and 30th of May, and singled July 3rd. The experimental swedes sown on the 22nd of May were only ready for singling on July 31st. The fly attacked all the swedes most virulently on the badly prepared land; there were scarcely a sufficient number of plants left for a crop, and some of these died away or became mere abortions after being singled. On the experimental plot (1-20th of an acre) there were 550 swedes of all sizes, weighing each about 2 lbs. on an average. On the part not manured with potash-salts there were also 550 plants. On both plots the swedes ranged from the weight of a few ounces each up to 8 lbs. 200 swedes averaged about 4 lbs. each, whilst the remaining 350 were only about a pound each. Large and small roots were mixed indiscriminately, irrespective of distance. Three swedes standing together, or 15 inches apart, weighed nearly 7 lbs. each; other similar spaces contained mere nuts in size. Had the plants

been regular, and all weighed as much as the 200 best, the weight per acre would have been 28 tons; and had every yard in length been equal to the best yard, the crop would have exceeded 40 tons per acre.

It follows evidently from these experiments and observations that in considering the efficacy of potash-salts as a manure for swedes, not much reliance can be placed on the increase of 30 cwts. of roots per acre, which was obtained from the part of the field manured with these salts, for the condition of the land at the time of sowing swedes had a very much greater influence upon the crop than the manure applied. No manure can compensate for a bad preparation.

Experiments with Potash-Salts on Potatoes, made at Burcott Lodge Farm in 1866.—The land on which the experiments were tried was dunged in the previous winter. To a portion of the field crude potash-salts were applied on the 28th of February, at the rate of 4 cwts. per acre. The soil was a red sandy loam, with a fair admixture of clay, but containing very little lime. On analysis, it yielded the following results:—

	Dried at 212° Fahr
Organic matter and water of combination	5·58
Oxide of iron	15·74
Alumina	2·56
Phosphoric acid	·19
Sulphuric acid	·13
Carbonate of lime	·50
Alcalies and magnesia	·95
Insoluble silicious matter	74·35
	100·00

The potatoes, York Regents, were planted on the 2nd of April, and were well up by the 25th of May. The crop was dug on September 14th. Produce: without potash-salts, 10 tons per acre; with 4 cwts. of crude potash-salts, also 10 tons per acre.

More than one-half of the potatoes were diseased, alike when grown with or without potash. The only difference I could notice was in the somewhat lighter green colour of the potatoe-tops where potash-salts were applied.

It is but right to state that the field on which the experiments were tried had been dunged two years previously, and had again received a good dressing of rotten dung for this crop; it therefore was evidently in too high an agricultural condition to give the potash-salts a fair chance of exerting any beneficial influence upon the potatoe-crop.

Potatoe Experiments with Dung and Artificials, made in 1866, *at Carleton, Carlisle.*—The last series of field experiments on which I have to report was carefully carried out by my friend

and former pupil, Mr. J. Raillow Hetherington, of Carleton, near Carlisle; they were tried on a piece of light land, which had formerly been a beech plantation, and had never grown any crop, except one of potatoes the year preceding the trials.

In the autumn of 1864, the roots of the trees were taken out, the land thoroughly drained, and afterwards trenched to a depth of 18 inches, and planted with potatoes in the spring of 1865. The land was deeply ploughed in the autumn of 1865, then cleaned and prepared for the potatoe experiments. The crop was planted on the 23rd of April. The seed potatoes, "Rough Whites," were obtained from a noted potatoe-grower in the neighbourhood. They were planted 12 inches apart, and 33 inches between the drills. Each experimental plot was 1-20th of an acre. The artificial manures employed in the experiments were mixed with twice their weight of finely powdered soil, and the mixture was sown at twice, in order to ensure equal distribution. The dung used was of excellent quality, made by fat cattle, and twice turned.

TABLE 1.—THE MANURES used in POTATO EXPERIMENTS at CARLETON, CARLISLE, in 1866.

Plots.	Name of Manure.	Per Plot of $\frac{1}{20}$ of an Acre.	Per Acre.
1	No manure	..	..
2	Dissolved bone-ash	22 lbs.	4 cwts.
3	Good rotten dung	1 ton	20 tons
4	Dissolved bone-ash	22 lbs.	4 cwts.
	and		
	Crude potash-salts	22 lbs.	4 cwts.
5	No manure	..	..
6	Crude potash-salts	22 lbs.	4 cwts.
7	Common salt	22 lbs.	4 cwts.
8	Dissolved bone-ash	22 lbs.	4 cwts.
	and		
	Common salt	22 lbs.	4 cwts.
9	Good rotten dung	1 ton	20 tons
10	No manure	..	..

Last season was very unpropitious for potatoes, and Mr. Hetherington informs me that complaints were made all over the neighbourhood that the potatoes never seemed to germinate properly. The frost on the 30th of April and the 1st of May literally closed the ground up, and a subsequent frost, about three weeks later, destroyed every bit of top which had made its appearance. The roots were taken up in particularly dry weather during the first week in October, and no dirt was left on them which could affect the weight.

The produce of each plot was carefully weighed, and the following results obtained:—

TABLE 2.—SHOWING the amount in lbs. of Large, Second, Small, and Diseased Potatoes obtained from each $\frac{1}{20}$ Acre Plot.

Plots.	Name of Manure.	Large.	Second.	Small.	Diseased.	Total.
		lbs.	lbs.	lbs.	lbs.	lbs.
1	No manure	125	58½	89	120	392½
2	Dissolved bone-ash	235½	103½	58	119	516
3	Rotten dung	287	92½	70	166½	616
4	Dissolved bone-ash and crude potash-salts	328	103½	51½	118½	601½
5	No manure	201	84½	84	82½	452
6	Crude potash-salts	282½	75½	88½	42	488½
7	Common salt	234½	81	66½	24	406
8	Dissolved bone-ash and common salt	349½	85	79	21½	585
9	Rotten dung	332½	111½	133½	73½	651
10	No manure	218	89	110½	17	434½

In the next table, the preceding results have been calculated per acre:—

TABLE 3.—SHOWING the Weight per Acre of Large, Second, Small, and Diseased Potatoes.

Plots.	Name of Manure.	Large.				Second.			Small.			Diseased.				Total.			
		tons.	cwts.	qrs.	lbs.	cwts.	qrs.	lbs.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.
1	No manure . .	1	2	1	8	10	1	22	15	3	16	1	1	1	20	3	10	0	10
2	Dissolved bone-ash	2	2	0	6	18	1	26	10	1	12	1	1	1	0	4	12	0	16
3	Rotten dung . .	2	11	1	0	16	2	2	12	2	0	1	9	2	26	5	10	0	0
4	Dissolved bone-ash and crude potash-salts	2	18	2	8	18	1	26	9	0	22	1	1	0	18	5	7	1	18
5	No manure	1	15	3	16	15	0	10	15	0	0	0	14	2	26	4	0	2	24
6	Crude potash-salts	2	10	1	22	13	1	26	15	3	6	0	7	2	0	6	7	0	26
7	Common salt . .	2	1	3	14	14	1	24	11	3	14	0	4	1	4	3	12	2	0
8	Dissolved bone-ash and common salt	3	2	1	18	15	0	20	14	0	12	0	3	3	10	4	15	2	4
9	Rotten dung . .	2	19	1	14	19	3	18	3	3	10	0	13	0	14	5	16	1	0
10	No manure . .	1	18	3	20	15	3	16	19	2	26	0	3	0	4	3	17	2	10

The produce on the three unmanured plots varied to some extent, as did also that on the two plots which received rotten dung. The greatest variation in the unmanured plots amounts to 10 cwts. 2 qrs. and 14 lbs., and to 6 cwts. 1 qr. in the dunged plot, as will be more clearly seen in the following table:—

TABLE 4.—SHOWING the Produce of each Manured and Unmanured Plot, the Average of the Unmanured Plots and that of Plots Dunged, and the Average Increase from Dung.

Plots.	No. 1.				No. 5.				No. 10.				Average.			
	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.
Unmanured	3	10	0	10	4	0	2	24	3	17	2	10	3	19	1	18⅔
	No. 3.				No. 9.											
Manured with dung	5	10	0	0	5	16	1	0	..				5	13	0	24
Increase by dung	..				..				..				1	13	3	5⅓

The average produce of the unmanured plots thus amounted to nearly 4 tons, and the dung, on an average, gave an increase of rather more than 1½ ton per acre.

Taking the exact average produce of the unmanured plots as a basis for calculation, we obtain the following increase or decrease in each experiment:—

TABLE 5.—SHOWING the Increase or Decrease in Potatoes on each Plot, calculated to the Acre, and Average of Increase or Decrease.

Plots.	Manure.	tons.	cwts.	qrs.	lbs.	Per Cent. Increase.	Per Cent. Decrease.
2	Dissolved bone-ash	0	12	2	25⅓	20·9	..
3	Rotten dung	1	10	2	9⅓	44·4	..
4	Dissolved bone-ash and crude potash-salts	1	7	3	27⅓	41·03	..
6	Crude potash-salts	0	7	3	7⅓	14·5	..
7	Common salt	0	7	1	16 (decrease)	..	4·8
8	Dissolved bone-ash and common salt	0	16	0	13⅓	25·4	..
9	Rotten dung	1	16	3	9⅔	49·1	..

On looking over the results of these potatoe experiments, the following points cannot fail to arrest the reader's attention:—

1. Foremost, he will notice that the heaviest crop was obtained by the use of good rotten dung.

2. But superphosphate and crude potash-salts, a purely mineral manuring, also gave a nearly equal increase. The mixture of superphosphate and crude potash-salts appears to be specially useful for root-crops on light land.

3. The efficacy of superphosphate as a manure for potatoes on light land is not only enhanced by potash-salts, but also, though to a minor extent, by common salt.

4. It is remarkable that whilst the addition of salt to superphosphate had a very beneficial effect, common salt alone slightly diminished the crop.

5. Potash-salts applied alone, though by no means the most desirable manure for potatoes, nevertheless had a better effect than common salt; for whilst crude potash-salts gave an increase of nearly 8 cwts. per acre, common salt produced 7 cwts. and 44 lbs. less than the unmanured plots on an average.

Perhaps it may appear strange that there were many more diseased potatoes on the first four plots than on the remaining six. This, however, I am informed, may be accounted for by the fact, that a small portion of the end of the first four plots was old land. On this old land, constituting about 1-30th

part of the experimental plots, the potatoes were very much diseased.

On the whole, the preceding experiments furnish practical evidence that the application of crude potash-salts in conjunction with superphosphate materially benefits root-crops grown on light and poor soils, which we may suppose to be naturally deficient both in potash and available phosphoric acid.

Laboratory, 11, *Salisbury Square, Fleet Street,*
July 1*st*, 1867.

XIII.—*On the Rearing and Management of Poultry on an ordinary Farm.* By Mrs. F. Somerville.

Prize Essay.

Introduction.

It is the writer's aim to make this Essay as plain and as brief as is possible when details are given, that it may be suitable to the requirements of a servant, or any one desirous to obtain a practical knowledge on the management of poultry; since it is the fruit of long and careful experience, gained by daily practice, it is not too much to hope that the same happy results that attended the labours of the writer may also requite those who may feel disposed to follow the advice herein laid down.

It is intended to point out the best system with regard to the breeding, rearing, and general management of poultry, more than to dwell upon and describe minutely the different breeds of which so many works now treat.

There are few creatures that conduce more to man's comfort than domestic poultry, whether he be in health or sickness; and, considering how interesting and profitable is the occupation, it is astonishing how few young people there are who make poultry their study, or even bestow upon it the attention it would so well repay. What a lesson of industry, vigilance, patience, perseverance, care, and affection, may be learned from the parent hen, that "gathereth her chickens under her wings"!

General Remarks.

There is no doubt that poultry may be kept and managed so as to produce a profit on all farms where corn and potatoes, or even swede turnips are grown, as the light or inferior grain cannot be sent to market in a more profitable shape than as well-fed poultry but, like all other farming stock, it requires constant

care and attention; and if you expect a full remuneration for your trouble, you must adopt a good system of management, and see that it is properly carried out in all points, from first to last. I do not think it would pay upon a small farm to keep a regular paid attendant; that occupation must be united with other employment, unless it is managed as a business, and first class poultry is bred and kept for exhibition, so that fancy prices can be obtained. Any sharp lad can, under proper directions and occasional supervision, look after and feed adult poultry, but to breed and rear successfully requires some experience. One would not think of trusting sitting birds or their young to youth; they require watching closely to keep the different broods steadily thriving; any check at this stage is a wasteful loss of time, and invites disease, whereas prevention is more important and more easily attainable than cure. The coops and sitting-house should be near the homestead, so that the farmer's wife, daughter, or at all events a confidential servant, may, without much loss of time, attend to those two principal points, thus getting a nice change from the sameness of indoor occupation.

Common Fowls.

Breeding.—Where there is defect, there is commonly a cause which may be traced out; and such is the case with breeding poultry. One of the greatest hindrances to rearing is unskilful breeding. How frequently do we hear of large numbers of the young dying without any apparent cause; but I generally find on inquiry into such cases that they have been bred from old birds and without an infusion of fresh blood in the stock for years; or that pullets' eggs have been set; in which case, should there be chickens, they are weak and delicate, and seldom attain perfection.

I keep five pure breeds of the common fowls, viz.:—Grey Dorking, Brahmapootra, Game, Spanish, and Moonies, and breed all the year round. For stock fowls I select the very best birds of the different breeds and mate them according to age, and with due regard to consanguinity: that is, of the same age, if two years old; or hens one year old, and cocks two; or vice versa; taking care that they are not too near akin, and that fresh blood be introduced, on one side at least, every two years, and never allowing more than five hens to one cock. My early and late chickens for table purposes are bred from the Grey Dorking hen by a Game cock, and the Brahmapootra hen by a Dorking cock, mated as aforesaid, which two crosses will answer the most sanguine expectations—the Brahma and Dorking especially—and those who do not care to keep a pure breed or wish to exhibit, cannot, I believe, select more valuable fowls: they are not to

be excelled as parents, layers, or sitters: their eggs are large, and the birds very good for the table. I have not the least difficulty in rearing chickens from any of the above-named breeds, and feel convinced that success depends upon the breeding and feeding.

I find that the cross-breds stand the winter months better than the pure breds, and therefore prefer the former to the latter, because of the high prices they will command at that season of the year. The question is often asked, What kind of fowls will pay the best to keep? The answer depends entirely upon the purpose for which they are chiefly kept. If for laying, I prefer the Moonies, having had pullets of that breed which have laid for twelve months, not missing more than two days a week. They are a good-sized fowl, and are handsome withal; but as table fowls, I should make choice of the Dorking or Game, or the cross-breeds, before alluded to.

The Hatching or Sitting House.—To some persons it would appear quite absurd to think of setting hens where they have not been accustomed to lay: but "where there's a will there's a way." The sitting-house is really a most important apartment, necessary to ensure the successful hatching of poultry; for how frequently do we see hens spoil their eggs by forsaking the nest when they are allowed to sit where they are hourly interrupted, and perhaps driven off their nests by other hens wishing to lay. To prevent all this, a separate apartment is required for sitting hens. It should be divided into compartments, of sufficient size to contain a nest for one hen, and so arranged that the hen can be secured on the nest by a lattice-door, allowing plenty of air; or the following plan may be adopted. The nests (14 inches wide, 14 inches high, and 16 inches from front to back) may range in two tiers along the lower part of a house (8 or 10 feet by 6), each nest being provided with a loose wooden door, reaching within 3 inches of the top, so as to admit of ventilation at the same time that the hen is secured on the nest; the door when closed is fitted into a groove at one end and fastened with a wooden button at the other; each button fastens two doors, and each door is numbered with paint, the corresponding number being painted on the *facia* of each nest.

I never set less than three hens at one time, and that number may always be had broody in the course of a week or ten days by leaving a few spoilt eggs in the nests where the hens you wish to set are accustomed to lay. The broody hens should be managed thus:—During the day make as many nests as you require in the sitting-house, with clean, soft, bruised straw, underneath which, during the summer months only, place a green sod: when evening arrives place the broody hens thereon,

and put under each hen three or four trial eggs (which should be kept for the purpose marked with ink), taking care to handle the hens dextrously, placing one hand underneath the breast, holding the legs in the other hand and carrying them upright; otherwise have a convenient basket for the purpose. Feed the newly-set hens as usual with the others, and in all probability at the end of two days they will have taken to the nests; in which case, when off feeding, on the third morning, place the eggs for sitting under each hen, and label each nest, naming the kind of eggs, and date when set. On the evening of the eighth day after setting take a lighted candle, and, holding the eggs up to the light, observe if they appear quite clear; if so, they are sterile or addle, for the eggs containing birds will appear opaque. It may happen, should there be many addle eggs, that two of the hens will sit the remaining eggs of the three; and one can be again set, with fresh eggs as before, and so on during the year. The sterile eggs should be marked as trial or nest eggs, or boiled as food for chickens, so that none need be wasted. As each sitting hen is now secured upon her nest, as many only at a time as may be most convenient can be let off to feed, which should be done early every morning inside the sitting-house with closed door, allowing them to remain off the nests fifteen or twenty minutes, and taking care that each hen returns to the proper nest. Give water, with grain in its natural state, but not with soft food. During the summer months, or dry windy March, and about a week previous to hatching, take a little warm water, and, when the hens are off their nests, sprinkle the eggs therewith: this will greatly assist nature in the process of. hatching, as the eggs are often very dry in hot weather: this, as a rule, applies to all kinds of poultry.

Feeding.—It is neither necessary nor desirable to go into the market for expensive feeding stuffs; still, there are several kinds of food not grown upon the farm, which yet are cheap and useful in the rearing of young poultry, or putting in condition birds intended for exhibition. One of the cheapest of these, if properly prepared, is rice, it can be bought at $1\frac{1}{2}$*d.* per lb., or even less; preference should be given to the small grain, or fine rice, which should be prepared in the following manner, viz.:—to 6 quarts of boiling water, add 2 lbs. of rice, and let boil for 10 or 15 minutes, according to the size of the grain, when sufficiently boiled, pour it into a hair sieve, and when cold, mix with as much oats or barley-meal, as will, when stirred lightly round with the hand, give it the appearance of small, well-dusted pills; each grain being then separate, it will be very convenient for, and is greedily devoured by young birds, and being very digestible, is an invaluable food for them.

Another kind of food for young birds is prepared by boiling two or three eggs until quite hard, afterwards chop fine, adding two or three handfuls of stale bread-crumbs; mix well together, so that the one cannot be eaten without the other. This may be thought expensive food, but as the consumption by young birds is at first very small, I always consider a little extra keep is not thrown away on them; you are forcing and growing birds that will repay you for all, and at no distant date.

Another description of food is Indian and barley-meal, in equal quantities, slaked with boiling water or milk, and served cold; it cannot be surpassed as food for small chickens, and answers admirably, given alternately with the rice and egg prepared as aforesaid. The youngest chickens I keep near the house, and feed very sparingly every two hours throughout the day, giving little or no water, as I find over-drinking spoils the appetite and brings on indigestion, which generally terminates in death. As they grow and become strong, they should by degrees be put upon the same food as adults, and any that promise to make prize birds are then transported to a run specially kept for the purpose, to which of course a little extra feed is carried.

The adult poultry I feed twice a day with light wheat, oats, or barley, given alternately with boiled potatoes, or turnips mashed up with ground oats or barleymeal, and I will guarantee this feed to keep them in good condition, and to produce plenty of eggs. Care should be taken in not supplying more food than is eaten, otherwise much may be wasted as is often the case, and I think if profit be looked for, more poultry should not be kept than can be conveniently and well cared for and fed with the produce of the farm, except as I have before mentioned, in reference to young birds or those intended for exhibition.

Turkeys

Are not so troublesome and difficult to rear as is generally supposed, and taking into consideration the present prices, it is a question if any of our domestic poultry are more profitable; it is not uncommon for a pair of turkey hens to rear thirty young ones during the season, which at an average price of 12*s.* each, are worth 18*l.*

There are several varieties, the two most useful and profitable being the Norfolk, or black, and the Cambridge, of metallic hue; in size and beauty the latter is pre-eminent. Never keep either male or female for breeding purposes beyond four years, neither depend entirely upon year-old birds; on a farm of ordinary size three hens and one cock will be found a sufficient number with other poultry. Take care to introduce fresh blood

in your stock occasionally from the best birds you can procure, and it is a wise precaution to keep on a young cock and a couple of hens as late into the season as may be convenient, for fear of loss or accident to your stock birds. Turkeys should be provided with an apartment to themselves, with perches, and fitted up on the ground-floor, with separate nests, so that each bird when sitting may be secured on her nest, otherwise on hearing the young at the time of hatching, they are apt to leave their own nests and interrupt each other, perhaps leaving some of the eggs to perish. As the laying season approaches place clean straw in their nests, with an egg by way of encouraging them to lay at home, as they are often inclined to lay astray, to the great danger of losing their eggs ; if the hen be seen seeking a nest, confine her in the place in which you wish her to lay; where the first egg is dropt there will she lay the remainder.

If fed alike they will generally all be broody at or near the same time, should this not be the case the first broody hen must be detained, until the others are ready (that is, supposing you wish to have a second flock, as hereafter described), then place a green sod at the bottom of each nest, with plenty of clean, short straw thereon, and allow the hens a day or two to form and take to their nests. The time of incubation is four weeks, and the hen will sit seventeen of her own eggs, if it is not intended to add a few common hen eggs, at the expiration of the first week's sitting, which is often done, with a view to the chickens encouraging the young turkeys to feed at the first onset. The sitting hens will require food and water daily, for which purpose they should be allowed to come out of doors, as they will not remain off their nests for a long time, but it should be observed that they return to their proper nests; about a week before hatching sprinkle the eggs with warm water, as directed in page 523, and on the actual arrival of that eventful period, ascertain by feeling under the hen whether the eggs are chipping or any birds out; if so, after taking out the shells, if any, leave her undisturbed for the day. It sometimes happens that an egg being slightly damaged, it is requisite that a portion of the shell should be very carefully removed, to allow the escape of the little prisoner, which otherwise might perish. With these exceptions, the turkey, like all other birds, is best left alone. The birds being now all hatched, allow them to remain about a day and a night with the mother in the nest, and on the following morning, weather permitting, place the hen under a roomy coop, with boarded bottom, and selecting a dry and sheltered spot, turn out the young birds in front thereof, feeding them whilst small every two hours with a little hard-boiled egg, alternately with rice, &c., as mentioned in pages 523, 524, not forgetting

to give the mother a substantial meal; after which she will soon gather the little ones under her wings. Should the weather be wet and cold, they must be kept under cover, and if confined beyond a week, a few onions, chives, dandelion, or dock-leaves must be chopped up and given with the egg; but this is not necessary when the mother and young can have their full liberty in about a week after hatching, in which case they will select their own vegetables and forage for themselves better than they can be fed by hand. Give water in dry weather after the young are a week old, but until they are three-weeks old do not allow it to remain by them after feeding. As they become strong feed four times, and by degrees come to three times a day with corn in the grain or other food. It is a critical time for young turkeys when the fleshy tubercles begin to appear on the head, generally termed striking the red, the birds being then about the size of a pigeon. The surest safe-guard is regular and wholesome food. I have known them to perish in a thunder-storm; to avoid this, a temporary shed should be erected at the spot to which you wish them to resort, near which they should be regularly fed, and water placed for them to drink, it is astonishing how quickly they will then seek its shelter on the approach of a storm. If turkeys be fed as herein advised, they will be found in sufficient condition for the market, without confining them for the purpose of fattening, as is often done.

I do not think it is desirable to aim at rearing two flocks in one year, but rather to use your best endeavours to raise one first-rate flock, the hens will then be in better condition for early work the following spring. The second hatch is generally very delicate, and subject to great mortality if the weather is at all unfavourable; however, in some establishments it is almost imperative to have a supply of late hatched turkeys during Lent, and after the game season is over, in which case, and when the first flock is hatched, confine one hen (giving the whole of the young to the others) in a coop or other convenient place for several days, feeding her well; afterwards set her at liberty, allowing the cock to accompany her, she will soon commence to lay again, and probably have her second flock hatched, and the birds will have attained strength ere the wet and cold weather sets in. They nearly always lay twice, and sometimes thrice during the season, and the desire to sit is very great; but by confining them a short time and feeding them well, you may easily put them off, without resorting to the uncouth way of plunging in cold water as practised by some persons.

There is no doubt that the rearing of turkeys is highly remunerative, and could be profitably extended if circumstances permitted; but if the corn-fields and mowing-grass are near the

homestead, I should not advise keeping too many, as a difficulty may be experienced in preventing their doing considerable damage to such crops, unless there be a conveniently situated pasture-field or plantation to which they could be taught to resort. Lastly (though not least) take them to the best market, and do not allow the dealers the profit, to which you are so justly entitled, but sell by weight alive; good birds will command a good price, which at the present time (February, 1867) is from 10*d.* to 1*s.* per lb. live weight. At Christmas last I sold a young cock turkey for 19*s.* 2*d.*, being 23 lbs. weight at 10*d.* per lb.; the rest of the flock weighed, cocks 18 lbs. or 19 lbs., and hens 10 lbs. or 11 lbs.

Geese.

Geese, like turkeys, are one of our largest edible birds, and second to none in value, considering the very little trouble they give from first to last, their usefulness upon the table, and the luxurious down and feathers which they supply; but a good sized pond, with a plentiful supply of water and good pasturage, are indispensable to make geese-keeping a paying business, for they are very large consumers.

The Toulouse are the largest breed; and as size is an object in the goose, care should be taken to select fine birds; this breed seldom attains full maturity for breeding until three or even four years old. Let them have an outhouse to themselves, regularly supplied with clean straw, with which make nests, on the floor, as the laying season approaches, and partition the nests off, according to the number required. One gander will be sufficient for three or four geese. When arrived at maturity, they generally lay about twelve eggs each, which number they will sit. The eggs, for safety, should be collected daily and placed in bran, with the narrow end downwards, until the geese, by remaining on their nests, show their desire for sitting; the eggs must then be placed under them, and the house so arranged that they can have free liberty of egress and ingress at all times of the day, as they will require food and water daily, to which they will help themselves, if a pasture-field and pond of water be near, and afterwards return to their nests; little attention is therefore required whilst they are sitting, beyond keeping their nests undisturbed and protected from vermin. When, after four weeks, the time of hatching has arrived, in case any young birds are out, see that all shells are removed, for fear they may cap the other eggs, and thereby prevent their hatching. Allow the goslings to remain in the nest for a day and night, they will not require feeding during that time, but will gather strength; and if the following morning be fine and

sunshiny they can be moved at once upon a grass plot or other convenient place, where they will be safe, and supplied with an abundance of nice young grass, of which they will soon partake (this, their natural food, suits them much better than to be crammed with oatmeal pellets), not forgetting to place them some water in a shallow vessel, with which a little oatmeal may be mixed. If the weather is unfavourable, they must be confined in an outhouse, and plentifully supplied with nice green grass turfs and water. The pellets alluded to are made of oatmeal, formed into paste with cold water, and of convenient size to be swallowed by the goslings; five or six are given at one feed for each bird; but to cram fifty goslings three times a day for a fortnight will be found a long and tedious job, and in most farmhouses time cannot be afforded for the purpose, besides, it is really not requisite.

The most critical time for young geese is about Midsummer; if it is very dry weather, and the pasturage and water not plentiful, it is then desirable to give them a few oats night and morning to assist nature over this peculiar juncture, and help them on until the stubbles are ready for them, and when those are cleared they will be in nice condition for fattening, which is best done by making them up, in lots of ten or fifteen in number, according to the size of the place, supplying them with plenty of water and an unlimited quantity of oats for three weeks, giving them a clean bed of straw when required; they will then be ready for the market. The day previous to killing turn them on the pond for the purpose of washing their feathers, and supply a bed of clean straw in the feeding-house before their return; but take away all food and water, and let them fast until killed the next day, when they must be dressed for the market. The price of the bird in December, 1866, was, in some places, from 10*d.* to 1*s.* per lb., small feathers 2*s.* 6*d.*, and the down 7*s.* 6*d.* per lb. It is unwise to sell green geese, on account of the loss in the feathers as well as the carcase, unless a fancy price is obtained for all together, but do not sell by weight at an ordinary price. There is not the slightest doubt geese pay well where there are proper conveniences for keeping them, but they must be well managed and kept out of the mowing-grass and corn-fields, or they will soon do damage to the amount of double their profit.

Ducks.

There are many varieties of ducks, but the two most profitable and best suited to the farmer generally are the Aylesbury, or white duck, with flesh-coloured bill, and the Rouen, which would be exactly like the mallard in feather, though much

larger in size. Both kinds are equally good, and gain great weight if properly bred and fed, and well supplied with water; they will weigh 16 or 17 lbs. per couple at 8 months old. In breeding for the market, ducks are best hatched under a common hen, and kept off the pond, they thrive better without access thereto, and are fit for the table at 8 weeks old; but those intended for store should have plenty of water, and be provided with a house, furnished occasionally with straw, and nests prepared, and if regularly fed they will become attached to their abode; otherwise they are apt to ramble, especially if there is a brook near, in which case many eggs are lost. They commence to lay early in the spring if well fed, and, if not allowed to sit, continue to lay until autumn. It is very desirable to have a good supply of early and late broods, which always fetch a high price. There is very little trouble in rearing ducks, whether the eggs are set under the common hen as before mentioned, or under the duck; the time of incubation is one month. Let the ducklings when hatched have a good nesting for about twenty-four hours, afterwards clip off the down at the tail to prevent their being drabbled, then place them with the mother in a coop, and feed with coarse barley-meal, to which water is added, making the food quite sloppy; afterwards give Indian meal and bran mixed up with buttermilk, so as to form a proper consistency, occasionally adding a few boiled potatoes by way of a change; and, as I have before stated, they will be ready for the market in 8 weeks, which is the chief end to aim at, and get them into money as soon as possible. Early ducklings are generally sent to the market in the feathers, but if kept over 2 months old, it is better to dress them, on account of the feathers, which are nearly, if not quite as valuable as those of the goose; and the duck, when dressed, is more convenient to the buyer, consequently, will command a better price.

In a work of this kind it would be quite useless to enter into a description of the many existing varieties of fancy ducks, which are of no value to the generality of farmers, or where mixed poultry is kept, on account of the additional convenience, care, and attention required.

Guinea Fowls

Are a useful and handsome bird, and are in season during the months of February, March, and April; they lay a great quantity of eggs during the summer, but, being of a wild nature, they generally lay astray, consequently their eggs are sometimes lost. Their flesh is of very gamelike flavour, and, coming in after the game-season, they are useful for the table; their eggs

are small, but fine flavoured, and always worth the same price as common hen-eggs, the price of the birds being generally about 7*s.* 6*d.* per couple. It is the best way, in case of breeding, to set the eggs under the common hen, the time of incubation being one month. After hatching place the hen under a coop, around which fix a guard to prevent the young straying, as they are very wild; they may have the same food as young turkeys (see p. 525). The coop, which should have a boarded bottom, will require to be moved to fresh ground every other day at least; after the first week the young birds should be shut up within the coop, to avoid injury whilst being removed; they may have their liberty when three weeks old, but the mother should be kept in the coop a week longer. The young will by degrees become tame and good foragers, and little difficulty will be experienced in rearing them under this method; but they are troublesome amongst other poultry, being regular attendants, however well fed, at the chickens' coops, besides being very quarrelsome, often driving the most spirited cocks before them, and perhaps injuring them in some way. From these remarks it may be inferred, according to circumstances, whether it is desirable to keep them, or not, upon an ordinary farm. I have made 8*l.* within a little, from one pair of birds during a season. As many males as females are required, as they always pair; the spotted variety is the hardest, the white are very delicate birds.

Pigeons.

There being so little trouble with these birds, it is desirable to keep a few at most places; they are always readily sold, and are in great demand when game is out of season and spring chickens are scarce. For breeding purposes they should not be kept too old; a convenient way of denoting their age is to cut off a nail of the claw every year, and a good cote with separate nests should be provided, and kept scrupulously clean, and a plentiful supply of rock-salt afforded. For the table and profit, the Blue Rocks are preferable to most other breeds; one pair will produce ten hatches during the year. Feed regularly, but scantily, as they will find the greatest portion of their own food.

Eggs.

Eggs should be gathered daily, in fact whenever they are to - ound, for fear of loss or accident; those from the select ,oultry should be placed in bran, with the narrow end downwards, marking thereon the date, as the preference is always given to the freshest eggs for setting, though they will keep good

for three weeks, and if you have more than required they may be sold at a good price. But ordinary eggs should be sold only when dear, and preserved when cheap, in the following manner:— If there are many, procure a tub that will contain, say 40 gallons, which place in a cellar or other cool room, and put therein one bushel of quicklime, 2 lbs. of common salt, and ½ lb. of cream of tartar, then add 30 gallons of cold water, and stir round a few times to mix the ingredients; afterwards leave until the following morning, when again stir up all well together. It should then be of such a consistency that an egg will float on the surface. Another vessel of convenient size must now be provided, in which the eggs are to be preserved, packing them close together with narrow end downwards (which should be done daily, after a commencement is made, as the fresher the eggs are the better), adding as much of the prepared liquor as will just cover the eggs; this must be done day by day until the vessel is filled within three inches of the top, then fill up the vessel with the liquor, and in a few days a crust of icelike appearance will be formed over the vessel, so as to keep it perfectly air-tight. Eggs (if fresh) preserved thus will keep as long as required, and for all cooking purposes will answer as well as the freshest, from which they can scarcely be distinguished. Having practised the system for years, I will guarantee it to have the desired effect, if properly carried out. Where labour is a consideration, eggs may be managed so as to pay better than rearing young fowls, as far less time and attention is required with laying hens; but the non-sitting varieties should generally be kept, though sitters will be required to produce early chickens, which must furnish the fresh eggs for the breakfast-table during the winter-months.

Conclusion.

No given rule can be laid down as regards the keeping and profitable extension of poultry on an ordinary farm, as so much depends entirely upon the conveniences and attendance— whether the latter can be performed by a member of the farmer's own family, whose time is not otherwise profitably employed, or whether it can be had at a reasonable rate; if not, a large number will have to be kept to produce a profit, after paying for special attendance; but if poultry of all descriptions are kept in large numbers on too small a space, the ground becomes tainted, and disease and death make their appearance amongst them. Poultry in some hands flourish and pay wonderfully well, whilst in others it is just the reverse; all depends upon the care, skill, and attention bestowed in the management thereof.

For the satisfaction of the reader I will state the produce

and value for one year of my poultry, as regards the female stock managed as herein stated. In some instances fancy prices were obtained, and prizes taken on exhibition, which, of course, are included in the value. No account of the quantity of food consumed was taken, as I had no intention of offering a statement to the public. It was, however, all grown on the farm, except about 4*l.* worth.

104 hens produced 13,739 eggs, exclusive of those set; they reared 372 chickens, besides hatching the ducks and guinea-fowls.

5 turkey hens reared 74 young.
6 geese reared 58 goslings.
Ducks hatched under hens: 79.
Guinea-fowls hatched under hens: 42. - Reared and sold.
Attendance: a boy and myself.
Total value of the above, 190*l.* 17*s.* 8*d.*

N.B.—7 store ducks kept; the guinea-fowls were the produce of one pair.

Manor Farm, Rufford, Ollerton.

XIV.—*Feeding Turkeys, Geese, and Ducks for the London Market.* By HENRY H. DIXON.

THE Eastern Counties may be said to have pretty nearly a monopoly of our English turkey raising and feeding. Hen-wives are generally "afraid to meddle with them" on the score of delicacy; but if the requisite food and attendance are not found to be thrown away in Norfolk and Cambridgeshire, &c., why should they be elsewhere, except in an essentially damp climate? They must be tenderly reared and not "dragged up," as the saying is. The Norfolk turkey is black, with a few white spots on its wings; and in no part of the county is the breed preserved in higher purity than at Sir William Ffolkes's. The Cambridgeshire turkey is of a bronze grey, and rather longer in the leg and bigger in the bone. Very few white ones are to be seen, as they are supposed, like a white long-horn cow, to be more delicate. The adherents of the Norfolk blacks consider that they lay on more flesh, and that it is whiter and finer in texture than that of the Cambridgeshire bronze; but as a rule the latter sort predominates in the East Anglian stubbles, and comes to the greatest weight. A good April-hatched cock at Christmas should average about 18 lbs. in his feathers, and a hen-bird about 10 or 11 lbs. in November, with ordinary feeding;

but if they have been "sent along" with Indian corn, barley-meal, rice, and potatoes, they will make up to nearly 2 lbs. heavier. The small Norfolk farmers generally keep a cock and three or four hens, and consider fifteen an excellent brood. The best broods are always hatched in April, and the second brood, which never comes to the same maturity and is eaten at poult-estate, follows in June or July. A September hatch too often realizes the rustic prophecy, "they'll never be fit, they won't live long enough." Cramp in the legs is very fatal to the broods; but it only kills them by lingering stages, and a disease in the head very often effects "a highly successful elimination." Wet is the young turkey's greatest foe. They are not let out of the coop till they have been hatched two or three days, and they should then be carefully watched and driven in from a shower.

On the smaller farms they are seldom finished off for market, and middle-men go round about the end of August and buy them up at an average of 4*l.* 10*s.* per score. They are then sold at a small profit, of sometimes only 6*d.* per head, to the larger farmers to "shack" upon the barley or oat stubbles, while the "swine well ringled" are put upon the wheat ones. By the terms of some leases the pigs and poultry are the only live stock which may be depastured on the young grass seeds layer. A turkey-boy is placed in daily attendance on the flock, to drive them home if it is wet, and keep them away from the trees, to which, true to their American forest origin, they are very partial. Nice bright plumage and wattles like red sealing-wax are capital symptoms, and if the cocks gobble, they are said to "talk healthy." Fighting is also a true sign of vigour, and so is fly-catching, when they are young. Besides what they get on the stubbles, they have abundance of indoor relief. The system of cramming them at night with force-balls is very much abandoned, and they are generally well kept on potatoes, barley-tailings, and light wheat, ground and mixed with milk. Common white turnips, which they eat greedily without slicing, tend to make their flesh white and to "cool their coppers;" and brickdust to scour their maw is never neglected.

They are killed simply by breaking their necks, and the breast-bone is always broken before they are sent off to the poultry-salesman, in order to give the breast a plumper appearance. The cocks, if sold out of their feathers to the neighbouring gentry, will fetch 1*s.* 2*d.* per lb. and the hens 1*s.*, or sometimes only 9*d.*, when a very plentiful season has knocked down prices, or they are not fed up to the mark. The bigger they are the higher their value per lb., on the same principle that salmon of 20 lbs. and upwards fetch 6*d.* more in the spring and early summer months for the large West-end dinner parties. The great bulk of them

go in their feathers to the London salesmen; but the wives of the smaller farmers take them picked to Norwich and sell them in the market, where very large ones, trussed and ready for the spit, have made 1*s.* 6*d.* at Christmas. Hen birds, which get fat sooner and are generally killed off before the end of November, are thought to be a daintier morsel than the "gobblers." Some two-year old cocks (beyond which age they are very seldom kept) have been killed at 30 lbs., when a heavy weight is wanted for an audit dinner; but with very high feeding, in one or two rare instances, prize birds have turned the scale at 40 lbs.

It is to Norfolk and Suffolk that we look for goose management on the largest and most economical scale. The goose trade of the great Norfolk dealers resolves itself into two branches,—the green geese and the Michaelmas. In March and April they begin to get in their gosling supplies from farmers or cottagers near the commons in both those counties. Most of these goslings are about five weeks old, and many of them in very poor plight; but six or seven weeks of feeding under stages, on barleymeal, maize, wheat-tailings, and brewers'-grains mixed, make them all ripe for the green-goose market. The Michaelmas geese take their places under the stages in August, and Norfolk and Suffolk are pretty well scoured before the dealers fall back upon the Irish and the Dutch supplies. The Dutch, which are principally grey, come from Rotterdam, and one of the largest Norwich dealers imported 17 tons' weight of live birds last year. They come over by steamers and sailing-vessels, packed in big flat baskets, but not to any great extent after the 1st of October. In the dealers' hands they are are fed on the same principle as ducks—low fare to begin with, and then on a gradually ascending scale. On turnips they are capital substitutes for sheep, and when a dealer has a turnip-field he not unfrequently hurdles off a portion of it and eats it off with them. They first clear the tops and then the bulbs of the softer turnips; but when they have a field of swedes to deal with, the man in attendance gives each turnip a chop. With this aid they eat far cleaner than sheep, and, in fact, leave nothing but their "taith," which answers admirably as a preparation for the next wheat-crop. Mangolds are not so much to their taste as turnips, but they eat the tops with a special relish. While they are busy with these green crops they require nothing but large troughs of water, and the finishing process consists in putting them under stages for a month, and feeding them on brewers'-grains and meal.

On the Western moors of Cornwall every one keeps geese, and they are bought up by jobbers in thousands for the stubbles. Summer Court on September 25th is the "goose fair" of the county; but they are only eaten there, and bargains are struck

under their savoury influence for draft ewes and wethers. Farmers all over England are supplied very largely both from Holland and Ireland. Geese are extensively bred in Moravia; and the hilly districts in Germany and Holland are peopled by a number of small goose-farmers, who get their living entirely by them. The Hussenheim goose-market is a very large one and of great antiquity, and, according to local tradition, the town owes its name to the bird of its choice. The Dutch hucksters buy goslings from the cotters,—who, like the burghers, are remarkable for turning the penny the right way,—at prices varying from 1*s.* 6*d.* to 2*s.** They are driven to Rotterdam, where they are packed up in crates, which are capable of holding about fifty or sixty each. Their voyage to Hull by the steamers is charged at 18*s.* per cwt., or about 5*l.* for 300 or 400 birds, and they are not fed until they are landed, and then with oats. From Hull they are forwarded to central market towns in railway trucks, each of which is capable of holding 230 birds. A small percentage of the more weakly ones die from being trampled on, and these casualties, with the expense of transit and sale attendants, bring up the price to about 3*s.* 9*d.*, when they are pitched in the market during August and September. The Irish collections are managed on a similar principle. If the goslings are purchased within reasonable distance of Dublin or Dundalk, they are driven to those ports, and if not, they are sent by rail. Liverpool, like Hull, is quite a "board of supply" for English dealers during the season.

Considerable supplies of ducks are also brought from Holland, and some turkeys as well; but the Norwich dealers' duck-supplies are mostly gathered in through the hucksters, from the small cottagers in the county. Rouens and Aylesburys have not been much used for crossing, and the supplies are generally of the small mixed brown and cinnamon sort, which has subsisted since the flood. The cottagers do not force their ducklings, but sell them to the dealers, one of whom takes 30,000 a year, principally in the duck-and-green-pea season. They come to him about 3 lbs. in weight, and after a week in the lean and three in the fat yard, they are turned out in prime condition, and with fully 1 lb. gain in flesh.

10, *Kensington Square.*

* We are indebted for these calculations to the 'Doncaster Gazette.'

XV.—*Extracts from the Report on the Agricultural Exhibition at Aarhuus (Denmark).* By JOHN WILSON, Professor of Agriculture in the University of Edinburgh.

EQUIVALENTS OF DANISH WEIGHTS AND MEASURES REFERRED TO.

Square mile is nearly	=	22· square miles (English)
Tönde (metrical)	=	3·8272 bushels ,,
,, (superficial)	=	1·363 acres ,,
Foot (fod)	=	1·0298 feet ,,
Inch	=	1·0298 inch ,,
Pound	=	1·1024 lbs. ,,
Pot (fluid)	=	1·1758 quarts ,,
Rigs-daler (96 skillings)	=	2·243 shillings ,,
Rigs-daler per Tönde-land	=	1·6456 shillings per acre ,,

DENMARK, which now comprises only Jutland and the Danish isles, is, comparatively speaking, so little known, and its agricultural system possesses features so different from our own, that a short sketch of its principal physical and economic features and of its productions is a necessary introduction to the Report which I have now to submit upon its great agricultural meeting.

The surface area of Denmark extends over 667½ square miles (Danish), or 6,866,061 Danish Tönder-land. The population, according to the last census returns (Feb. 1st, 1860), amounted to 1,600,551 persons, of which number 737,204, or 45·43 per cent., were engaged in agricultural pursuits.*

The character or rather quality of the soil is expressed by an arbitrary standard of comparison peculiar to Denmark, to which we have nothing analogous in our own country nor in the other countries of Western Europe. This I will now endeavour to explain.

From a very early period in Danish history the different grain crops cultivated in the country were divided into "hard corn" and "soft corn." Barley and rye represented the first, and oats the second; wheat at that period was not known as a farm crop. As the land was held by different proprietors in differing quantities, and differed itself in quality, it was thought advisable, in 1656, to define their qualities and values by some fixed and readily recognized standard, and all rents and imposts on the lands were reduced into their estimated equivalents of "Hartkorn" (hard corn). The Amtmann of the district summoned meetings of the principal proprietors and of those qualified to assist in such an investigation, the quality of the land was deter-

* 'Statistisk Udsigt over Danmarks Landbrug.' Kjobenhavn, 1866.

mined by them, and the rents fixed according to its estimated produce. The most productive was rated as high as 40 rigsdalers the Tönde-land, while the inferior qualities ranged as low as 2 r.d. per Tönde-land.

In 1660, when the crown of Denmark was made hereditary, and a fixity thus given to the Government of the country, the taxes and other fiscal imposts were calculated on the amount paid for rent, which itself was determined by the estimated produce of the land in Hart-korn. Owing to some irregularities in the working of the system, revisions and alterations were needed, and in 1681 a second general survey was made of all the cultivated lands, and a rigid re-measurement and re-valuation were carried out. The meadow lands were rated according to their estimated produce in hay; the pasture and grass lands according to the amount and nature of the stock they could carry; and the arable lands were divided into Tönder-land, and their value estimated according to the amount of Hart-korn they could produce. In 1804, and again in 1827, fresh valuations were made, and the old superficial measurements either confirmed or rectified. In 1840, these were again subjected to supervision, and the taxes of the country re-arranged. At the present date, every portion of the surface, except that occupied by roads or by water, is valued at so much "Hart-korn per Tönde-land," and is assessed for imperial or local taxation according to this rate.

For the best qualities of land, such as is met with in some of the islands, the taxes are fixed at 1 Tönde of Hart-korn for each 6 Tönder-land of surface; for the medium class of soils at 1 Tönde of Hart-korn for 12 Tönder-land; and for the inferior qualities of soils at 1 Tönde of Hart-korn for 100 Tönder-land of surface. The average rate of assessment of the whole territorial area may be taken at 1 Tönde of Hart-korn for each 20 Tönder-land of occupied surface. When any land is offered for sale, the Hart-korn value is always specified as well as the extent of surface.

The large properties, or farms "Herred-gaard," are usually let on leases of 12 to 15 years, with covenants as to the mode of cropping and farming as stringent and often as obstructive as our own. Rents are paid either wholly in money, or half in corn and half in money; the rates for ordinary farming-land ranging from 10 to 15 r.d. per Tönde-land. The small farms or properties, "Bönder-gaard," are usually let for longer periods, such as 50 years, or for a certain number of lives. The farm-labourers are usually engaged by the year. They are lodged and boarded in the house, and paid at the rate of 40 to 60 r.d. per annum.

This brief explanation will, I hope, be sufficient to render the

following statistical statement of the quality or character of the land readily intelligible, although expressed in a form so entirely different from what we are accustomed to at home.

The meadows, woods, and arable lands are valued at 375,069 Tönder of Hart-korn, of which 203,809 are on the islands, and 171,206 are in Jutland. These are divided amongst 1754 large proprietors, who possess altogether 50,118 Tönder of Hart-korn, giving an average amount to each of 28·6 Tönder Hart-korn, and 69,094 small proprietors, who possess 278,528 Tönder Hart-korn; thus averaging an area equal to 4 Tönder Hart-korn each. There are besides 136,925 small occupiers of houses with less than 1 Tönde Hart-korn attached, who possess together 34,531 Tönder Hart-korn, or an average of about ·25 Tönder each; and in other small occupations of various descriptions an area exists equal to 5122 Tönder Hart-korn. Thus the entire surface is occupied in the following proportions:—

	Per Cent.
By large properties	13·6
By small properties	75·6
By occupations under 1 Tönde Hart-korn ..	9·4
By small occupations	1·4
	100·0

These two classes of landed proprietors vary somewhat in their relative proportions on the islands and on the mainland (Jutland), the large estates increasing on the islands, while the proportion of small estates is greatest on the mainland.

	Number.	Possessing Tönder-land.	Percentage. Proportion.
On the Islands.			
Large proprietors	1,024	32,724	16·3
Small ,, ...	30,391	147,347	73·7
Small occupations with houses	67,545	16,705	8·4
,, ,, without buildings ..	..	3,205	1·6
			100·0
Jutland.			
Large proprietors	730	17,394	10·3
Small ,, ...	38,703	131,171	78·0
Small occupations with houses	69,380	16,705	10·6
,, ,, without buildings ..	..	1,917	1·1
			100·0

The surface area was, according to the last returns (1861) occupied in the following manner:—

	Tönder-land.
Productive area	4,753,278
Unproductive	2,112,783
	6,866,061

Productive occupation—	
In tillage cultivation, as corn, roots, and economic crops	1,962,183
In meadows, grass, and irrigated lands, fallows, &c.	2,474,393
In woodlands	316,712
	4,753,288

Unproductive—	
Waste lands, moors, &c.	2,032,245
Water	80,538
	2,112,783

The relative proportions of the productive area are—

	Per Cent.
In tillage occupation	41·28
In permanent grass, &c.	52·06
In woods	6·66
	100·00

Tillage Area under Crop.	Tönder-land.	Percentage. Proportion.
Wheat	112,358	5·72
Rye	378,873	19·31
Barley	549,743	28·02
Oats	649,264	33·09
Pulse	75,908	3·87
Buckwheat	49,145	2·50
Seeds	61,078	3·11
Potatoes	55,341	2·82
Roots	4,508	·23
Rape	12,872	·66
Flax and Hemp	7,270	·37
Carraway, &c.	5,814	·30
		100·00
GRAZING LANDS, &c.		
Grass pastures	1,408,322	57·01
Natural meadows	433,635	17·53
Irrigated ,, ...	308,385	12·46
Fallows	324,051	13·10
		100·00

The average yield of the principal tillage crops is thus given—

Wheat	1,100,000	or about	10	Tönder	per Tönde-land
Rye	3,400,000	"	9	"	"
Barley	6,000,000	"	11	"	"
Oats	7,700,000	"	12	"	"
Buckwheat ..	25,000	"	5	"	"
Pulse	600,000	"	8	"	"
Mixed seeds ..	300,000	"	10	"	"

The gross produce of the cultivated land is appropriated as follows:—

	Tönder.	Per Cent.
For seed	2,250,000	11·7
,, Food for cattle, &c.	7,900,000	41·6
,, General consumption ..	5,500,000	29·4
,, Export	3,420,000	17·3
		100·0

In 1865 the surplus agricultural produce exported consisted of—

	Tönder.
Wheat	466,357
Rye	543,331
Barley	1,537,417
Oats	815,504
Peas	29,967
Beans	8669
Tares	2311
Rape	147,782
Malt	4404
Flour	212,130
Miscellaneous	6057
Total	3,773,910
Oilcakes	7,081,840

The last statistical returns of live stock were made in July, 1861, and were as follows:—

Horses.		
Stallions	4671	324,560
Mares	170,411	
Geldings	112,775	
Foals, under two years	36,703	
Cattle.		
Bulls	21,080	1,118,774
Cows	756,834	
Oxen	76,758	
Heifers, and under two years ..	264,102	
Sheep.		
Over one year old	1,051,517	1,751,950
Under one year old	700,433	

Swine.

Over one year old	62,181	300,928
Under one year old..	238,747	

Annual live stock produce (1860):—

Foals	20,005
Calves	521,670
Lambs	739,675
Pigs	289,849

This would give an average of the several descriptions of stock per 1000 of the population of—

Horses	203	or	468	per square mile.
Cattle	699	„	1612	„
Sheep	1094	„	2524	„
Swine	188	„	433	„

The average annual butter produce is estimated at 50,000,000 to 51,000,000 lbs.

After providing for the requirements of the population, there remained (1865) the following surplus stock and animal produce for exportation:—

Horses	3501	
Cattle	38,934	
Calves	639	
Sheep	29,851	
Swine	39,058	
Dead meat	1,440,345	lbs.
Bacon	9,932,312	„
Butter	41,145	barrels.
Wool	2,900,307	lbs.
Skins	5,385,230	„
Bones	4,557,459	„

The climate of Denmark appears to be not very different from our own. From the returns which have been furnished to me by the Meteorological Committee of the High Agricultural School, it appears that the mean monthly temperature recorded at Copenhagen for the past 72 years has been—

	Fahr.*		Fahr.
January	29·75°	July	61·7°
February	30·61°	August	62·31°
March	33·62°	September	56·28°
April	42·99°	October	46·6°
May	51·75°	November	39·02°
June	59·81°	December	33·65°

The mean Winter (December, January, and February) temp. was		31·46°
„ Spring (March, April, and May)	„	42·46°
„ Summer (June, July, August)	„	62·00°
„ Autumn (September, October, November)	„	46·64°

* In Denmark Réaumur's thermometer is used. The degree of Réaumur is equal to 2·25° of Fahrenheit, or as 4 is to 9.

The rainfall which has been recorded at the same place for 44 years gives the following mean monthly quantities for that period :—

	Inches.*		Inches.
January	1·71	July	2·28
February	1· 5	August	2·46
March	1·55	September	2·16
April	1·45	October	2·16
May	1·48	November	2·00
June	2·10	December	1·67

The mean amount of rain falling—

During the winter quarter has been	..	4· 9 inches.
" spring " "	..	4·47 "
" summer " "	..	6·85 "
" autumn " "	..	7·15 "

The mean number of days on which either rain or snow, hail, &c., has fallen in each month, recorded for a period of 32 years, was 157, occurring as follows :—

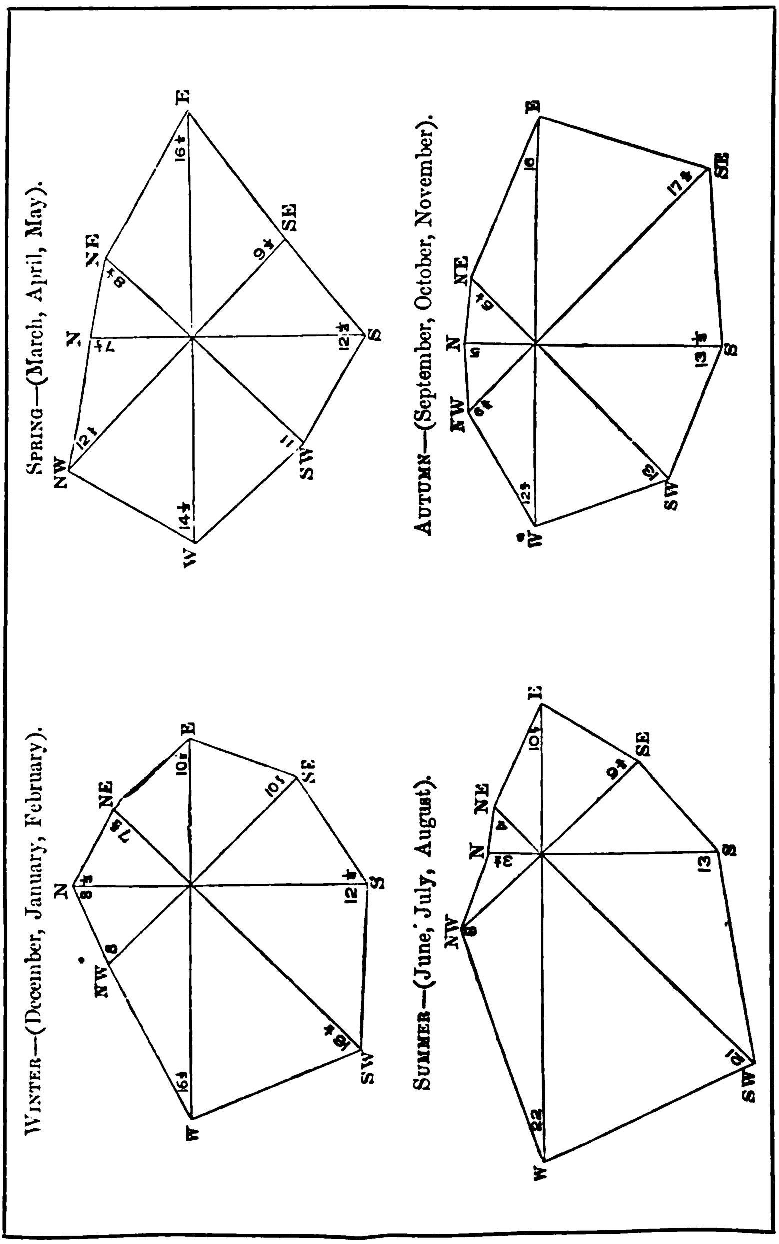
January	15	of which snow fell on	7 days.
February	12	"	6 "
March	13	"	5 "
April	11		
May	11		
June	12		
July	14		
August	14		
September	13		
October	15		
November	14	"	1 "
December	13	"	4 "

The mean number of days on which wet fell in the

Winter quarter was	.. 40	of which snow fell on	17
Spring "	.. 35	"	6
Summer "	.. 40	"	0
Autumn "	.. 42	"	1
	157		24

The prevailing winds for the four seasons and for the year, calculated from observations taken three times daily at Landboheisholm, 50° 41′ N. latitude, 0° 2′ longitude W. of Copenhagen (average of three years), are represented by the following diagrams :—

* The Danish inch is equal to 1·0298 inch (English).



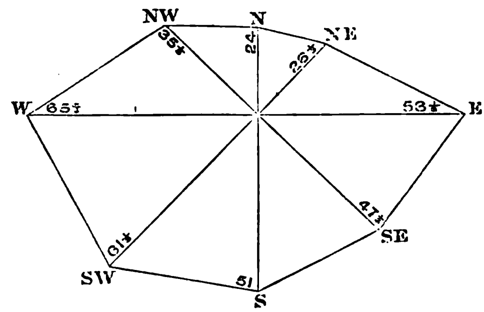
Spring—(March, April, May).

Autumn—(September, October, November).

Winter—(December, January, February).

Summer—(June, July, August).

Average for the Year.



This brief and condensed sketch, though very imperfect, will, I hope, serve to convey a pretty good general idea of the agricultural character and capabilities of the country.

The Exhibition comprised five distinct departments, which were located in as many different places, though all were within an easy distance of each other.

1. Machines, Implements, and Tools.
2. Butter and Cheese.
3. Seeds—Agricultural and Forest.
4. Fish, and Fishing appliances.
5. Live Stock.

The four first departments were open during the whole period of the meeting, from the 24th to the 29th June inclusive. The last was only exhibited on the 28th, the stock being removed the next day.

The prizes and honorary awards were on a very liberal scale. In the "Machine and Implement" department medals were given in silver and bronze. In the "Dairy Produce" department medals were given for large dairies' butter, and for small dairies' butter (under twenty cows), and for whole milk and skimmed milk cheeses, besides money prizes of 25, 15, and 10 r.d. each. In the third department, medals were given. In the "Fishery, &c.," department, silver and bronze medals were given for preserving fish—for preparing fish for food—and for tackle and appliances for catching fish. In the "Live Stock" department, money prizes were awarded to a large amount in the following proportions:—

For the Horse classes in all		2,800 rigs-dalers.
Cattle	„	2,845
Sheep	„	355
Swine	„	160
Fat Stock	„	1,000
Or a total of	.. ..	7,160 equal to 796*l.* sterling.

Machines and Implements.

The various objects comprised in this department were divided into sixteen different classes; and there were 182 exhibitors. Several of our own firms were creditably represented, though their contributions were not on the same scale as at the Vienna meeting, probably because the limited nature of any possible demand for their manufactures in Denmark more than counterbalanced the greater facilities of transport to Aarhuus.

Experimental trials in the field were conducted during the week preceding the Exhibition, under the personal superintendence of Prof. Jörgensen, of Copenhagen (to whom I am greatly indebted for the facilities and information he afforded me during my visit), and a special jury; and opportunities were afforded each morning of the Exhibition of seeing some of the principal machines, such as reapers, &c., in operation, close to the show ground. These appeared to attract attention and give general satisfaction.

The following prizes were awarded to the English exhibitors:—

Silver Medals—to Clayton and Shuttleworth, for steam-engine and compound threshing-machines with straw elevator; Hornsby and Sons, for steam-engine and threshing-machine, and for reaping-machine; John Baker, for corn dressing-machine; J. and F. Howard, for ploughs and harrows; Spear and Jackson, for hand implements.

Bronze Medals—to W. S. Underhill, for turnip-sowing machine; R. and R. Hunt, for horse-hoes.

The "Butter and Cheese" department was, as might be expected, upon a much larger scale than we are accustomed to at ordinary agricultural meetings. Both the larger and the smaller class of dairies were well represented; and the samples of their respective produce, in butter and in cheese, were so numerous as not only to occupy much time, but to give the judges considerable difficulty in making their awards.

In the third department, "Agricultural and Forest Seeds," the samples exhibited were too limited in quantity to admit of any fair comparisons or judgment of what their quality would be in bulk. They were generally very neatly and creditably arranged, but on a scale more suitable for a museum collection than a great agricultural exhibition.

The "Fish and Fishing appliances" exhibited were also of a very meagre description; certainly not equal to what a seagirt country like Denmark was capable of furnishing. This branch of our food-producing industries appears to have been lately exciting more attention in different countries than it formerly

did; but certainly not more than it deserves. In countries like Denmark and our own, with such an extent of coast line, the sea offers a field for occupation where the harvest is of a permanent and well-nigh illimitable character—where no seed or seed-time has to be considered, and where the crop is always ready to be gathered in when the elements permit the tillers to leave their homes.

In Holland, in France, in Norway, and in Sweden, special exhibitions for illustrating and developing the fishing resources of the respective countries have already been held. At the recent meeting at Vienna it formed an interesting department, and announcements have been made public of an exhibition to be again held in Holland in the coming summer of 1867, for the same object.

Would it not be well for us to follow the example thus set us by countries whose natural fishing facilities are not greater, and whose food pressure is certainly not so great as our own.

The "Live Stock" were, as usual, the great object of attraction on the single day set apart for their exhibition.

Another circumstance tended no doubt to swell the numbers that attended the meeting on that day—the presence of the King, accompanied by the Crown Prince, the Czarowich, and the Grand Duke Alexis of Russia. Each department was visited in detail, and the greatest interest was manifested by his Majesty in everything that tended to illustrate the present or to improve the future condition of the agriculture of the country.

The "Live Stock" was arranged in four divisions—horses, horned cattle, sheep, and swine—and these again were subdivided into different classes.

The several "Horse" classes were very well represented, and contained some very well-shaped useful animals, whether for road or purely agricultural work. Those selected by the judges as worthy of a prize had to substantiate their claims to it by performing in harness, in a satisfactory manner, a given distance, with a certain weight of draught in a certain time. The horses were thus seen in action at the work for which they were stated to be suitable, and their qualities, good or bad, were thus brought out more prominently and more fairly than would be done by the ordinary mode of judging.

The Jutland horse is generally a well-bred, good-shaped animal, from 15 to 16 hands high, rather heavy and sluggish in appearance, and suitable for road as well as field work. The prevailing colours were bays and browns. Some years ago some English thoroughbred stallions were imported for improving their breed; and more recently, Cleveland blood has been resorted to for the same purpose, but in neither case were the

results so satisfactory as was expected. They have no doubt, however, done some good, as many of the horses exhibited possessed many points of resemblance to the Yorkshire breed. There were 164 horses on the ground; they were generally in good condition, and well groomed.

In the "Cattle" classes prominence was duly given to the breeds best suited for dairy purposes, of which several excellent specimens were exhibited, both of the native Jutland and the Slesvig breeds. The Jutland dairy breed is of small size, generally black or white, or of a dun colour, with coarse heads and muzzles—not at all prepossessing in appearance, but presenting great opportunities for improvement by judicious selection in breeding, or by crossing with other suitable breeds. The Angel (Slesvig) breed is darkish red in colour, small in size, but well shaped, with fine symmetrical heads and necks, good quarters, and all the characteristics of good milkers. The class for collective specimens of the particular breed afforded a good opportunity of forming a satisfactory judgment of the stock of the exhibitor, as the bull, cows, and their produce, were placed together in each lot.

There does not appear to have been at any time much infusion of foreign blood into the native breeds of the country, neither did the stock exhibited indicate that careful selection in breeding which we consider so important at home. In the mixed-breeds classes there were a few crosses with the Alderney and Ayrshire blood, but no pure specimens of either were shown.

A little more attention to the preparation of the stock generally for exhibition, expecially as regards cleanliness, would have materially improved their appearance. Many were too low in condition for even ordinary purposes. The same observations which I ventured to make with reference to the stock exhibited at Vienna are even more applicable here.*

* "Rarely out of our own country do we find the same amount of care and attention bestowed on the preparation of stock for exhibition that we are accustomed to at home. This difference of treatment has its advantages as well as its disadvantages. The animal is shown in its natural every-day condition, with all its points, good or bad, fairly exposed, and its merits or defects open to an easy judgment. It has not been forced by early and rich feeding to assume abnormal proportions or an undue maturity, too often at the cost of its natural powers, but stands as the honest representative of what it professes to be, and visibly justifies the value that is placed upon it. At the same time the unprejudiced visitor from England must, without attempting to defend the exaggerated mode of preparation at home, observe the general depreciation which stock of any sort undergoes when exhibited without that due attention to condition and cleanliness with which all stock properly cared for ought always to be treated. These are indeed points which, though frequently sadly neglected, are as liable to affect the general health and vigour of an animal, as is over-feeding, though in different ways, and certainly claim attention from the owners of stock in the Austrian Empire."—*Report on the Agricultural Exhibition at Vienna*, p. 32.

The different classes were well represented, comprising no less than 438 entries in addition to the separate collective lots (19 in number) of bulls, cows, and offspring. The cattle, as well as the horses, were all exhibited in the open, tethered in rows according to their respective classes; fortunately the weather, though intensely hot, was most favourable for both men and beasts.

The "Sheep" classes contained nothing which calls for special notice. The old Danish breed is well-nigh displaced entirely by the introduction of the Merino or English breeds. In some cases crosses have been effected, but in none of the specimens exhibited were the results to be compared with the pure imported breeds.

The class contained in all 135 entries, inclusive of the fat stock, about 40 in number.

The "Swine" classes were poorly represented. In all the specimens exhibited, English blood—Yorkshire or Berkshire—gave the stamp of value to the respective pens. Indeed, neither the sheep nor swine class were quite equal to what might reasonably have been expected in a country so purely agricultural as Denmark—a country too which has a large annual surplus produce to dispose of, in which *quality* is, or ought to be, always a matter of primary importance.

Taken altogether, the Exhibition, though somewhat unequal in its departments, was a great success, and most creditable to a country so limited in its population as Denmark now is. The numbers that visited it were far in excess of those at any previous meeting, and must have contributed satisfactorily to the funds of the Royal Agricultural Society, under whose direct superintendence it was held, and been equally gratifying to the excellent and indefatigable President, Count Holstein-Holsteinborg.

The Royal Agricultural Society was established in 1769, and consists of three presidents, a council of 12 members, and about 300 ordinary members, who each pay 10 rigs-dalers per annum. In addition to the subscription the society receives an annual subsidy from the Government of 1600 r.d. Its great meetings or exhibitions are held every third year, the locality being changed for each meeting. Besides this central society for the practical encouragement of agriculture, there exists an excellent school at Copenhagen for teaching those principles of the art, the application of which it is the function of the Royal Agricultural Society to develope and encourage. The Royal Veterinary and Agricultural High School (Kongelige Veterinair-og-Landbohoiskole) was organised in its present form in 1857, and is intended to teach agriculture, agricultural engineering, vete-

rinary practice, forest and garden cultivation and management, for each of which there are separate departments. The teaching staff consists of seven professors and ten docents or teachers, who are attended by an average number of 250 students.

The regular course of teaching comprises the following subjects, which are thus arranged by the—

Seven Professors	*and Ten Docents or Teachers.*
2. Pathology.	Mathematics.
1. Anatomy.	Botany.
1. Hygiène.	Zoology.
1. Chemistry.	Geology.
1. Agriculture.	Mineralogy.
1. Surveying, &c.	Forestry.
	Horticulture.
	Engineering, &c.
	Plan Drawing, &c.
	Veterinary Jurisprudence.

The duration of the school course of study varies in the different departments, viz. :—

The Agricultural course lasts	2	years.
„ Veterinary course lasts	4½	„
„ Engineering and Surveying course lasts ..	4½	„
„ Forestry course lasts	2½	„

The classes are held continuously from August to May, when Examinations are held in each of the departments, and Certificates of qualification (1, 2, and 3 class) given to the successful candidates. The Government gives an annual subsidy of 40,000 r.d (4500*l.*) to the Institution. The cost to the student is limited to 12 r.d. per annum for the entire course of lectures, with the addition of 10 r.d. per session, with half the cost of the materials used by those who work in the laboratories. These fees, however, do not go towards the sustentation of the school, but go to form a fund, which is placed under the control of the Professors, for the purpose of defraying the expenses of the poorer class of students who would otherwise be unable to avail themselves of the teaching of the Institution.

One of the most important and interesting features of the meeting, and which is, so far as I know, peculiar to the great meetings of the Danish Agricultural Society, was the discussions which were held each morning during the week of the Exhibition. The questions appointed for discussion were introduced by members specially acquainted with the subjects, and appeared, from the vigour of the discussion and the numbers present, to attract attention and give great satisfaction.

The following list of the questions for discussion at the Aar-

huus Meeting will give some idea of the mental calibre and proclivities of the Danish agriculturists:—

1. What new experience have we in respect to the proper treatment and manufacture of butter and cheese?
2. Considering the climatal advantages that may result from planting and irrigating on a large scale the moorlands of Jutland, it is desirable to consider by what means these advantages can be most profitably secured.
3. How are the working population of the rural districts housed; and by what means can their dwellings be enlarged and improved?
4. Would it be right to graze the land under woods,—is it even advisable to do so?
5. Do we pay sufficient attention to the cultivation of fruit-bearing trees; what can we do to improve them?
6. Consideration of the means to be adopted to meet the future demand for instruction in "Rural Economy" by smaller farmers.
7. Ought we not to pay greater attention to the manufacture of meat,—in what direction ought the practice of feeding to be extended?
8. Are our present means of transport of live stock to English ports sufficient to satisfy the export requirements of the country?
9. Are there any good reasons for trying to obtain an alteration in the law of January 26, 1863, as far as it excludes the older stallions from competition for the Government prizes at the local shows?
10. What value ought to be attached to the trial of strength in judging the horses;—ought this test to be introduced at the local shows?
11. Has drainage answered our expectations, and has this mode of improvement effected an alteration in the mode of utilising and treating the land?
12. Can the present condition and produce of our agricultural land satisfy the claims incurred by our improvements in farming?

I venture to make but one comment upon this list, in reference to the great number and variety of subjects proposed for discussion, for which the time set apart was totally inadequate.

The same practice of issuing admission tickets for the whole period of the Exhibition, and of a public distribution of the prizes, that I met with at the Vienna Exhibition, is followed at the Danish Agricultural Meetings, and with the same beneficial results.

Not that the ceremonial of the distribution of prizes at Aarhuus

could be compared, so far as pictorial effect went, with that at Vienna. The presence of Royalty, and the varied and striking costumes of the different nationalities taking part in the proceedings there, gave a colouring to the latter which probably no other country could have produced. Here, however, the business of the day was conducted in a more simple and more serious manner. Although the nobles and larger proprietors were well represented, the great majority of the recipients were well-to-do yeomen farmers, as independent in their circumstances as in their characters, all wearing the same national dress of the plainest materials, all speaking the same language, and all joining heartily in praising their country and the King to whom they owed allegiance.

The President of the meeting, Count Holstein-Holsteinborg, distributed the prizes, the animals being paraded past the tribune in succession as the prizes were presented to the successful exhibitors.

Besides the regular discussions already alluded to, another practice exists at the meetings of the Danish Agricultural Society, which not only adds to their general interest, but also tends greatly to the benefit of the visitors generally, and especially of the smaller farmers. Excursions are arranged for visiting some of the leading farms and most improved estates in the district, where they have an opportunity of examining and of seeing carried out in practice those advanced systems which have been recommended to them by the Society, and perhaps discussed at the meeting itself. On this occasion, while one large party proceeded inland by the railway, others went east and west—by steamer or by road—to visit the fine farming and dairy establishments of Mr. Saxtorth, at Vosnœsgaard, and of Mr. Dahl, the Amtmann of the district, at Moesskov, where, notwithstanding their numbers, they were received with a most lavish hospitality, and conducted over every department of the farms. In the evening, a visit from the King and the Russian Princes and their suites to Moesskov, added not a little to the enjoyments of the place.

The next great Meeting of the Society is to be held, I believe, at Copenhagen in 1869. As that will be the Centenary Commemoration of the foundation of the Royal Agricultural Society, no exertions will be spared on the part of Denmark to ensure a successful meeting. If an invitation be then again given to foreign farmers to take part in the proceedings, it is to be hoped that ours will not be laggards in accepting it. The agricultural conditions of the two countries seem to be to a great extent complementary of each other; the more we know of each other's wants and requirements, the better able shall we be to supply them.

XVI.—*Results of Experiments on the Potato Crop with reference to the most profitable size of the sets; the influence of thick and thin planting, &c., carried out in the years* 1864 *and* 1865 *at Benthall, near Broseley.* By George Maw, F.S.A., G.S., L.S., Member of the Royal Agricultural College.

Prize Essay.

The striking evidence obtained from a few experiments made during the year 1864 with the object of ascertaining the sized potato-set most profitable to plant, induced me during the past year to carry out a more extensive series on a systematic scheme; a brief report upon which I beg to lay before the Royal Agricultural Society of England.

The 129 trial plots, described in the accompanying tabular statement of general results (at pp. 564-569), were arranged with special reference to the following questions, which I propose to consider under separate heads.

Firstly. As to the influence of the size of the set on the economic results of the crop; *i. e.*, whether any increase, and to what extent, is obtained over and above the extra weight of the set, in the planting of large in lieu of small sets.

Secondly. As to the influence on the crop of the distance at which the sets are planted; or the results of close and wide planting of various sized potatoes.

Thirdly. As to the comparative results from planting similar weights of large and of small potatoes per acre.

Fourthly. As to the relative advantages of cut and whole sets.

Fifthly. As to the influence of thick and thin planting, and of the size of the set, on the proportion borne between the weights of the sets and the weight of the crop, and the rate of increase under various conditions.

Sixthly. As to the relative productiveness of different varieties of potato.

Much diversity of opinion seems to prevail on these points, which are of economical importance in relation to both the Farm and Garden cultivation of the crop.

The selection of the potato-sets appears commonly to be more a matter of present expediency than prospective profit. The general course is to appropriate the largest for use, the very smallest for pig-feeding, the tubers of intermediate size being preserved for replanting; this method of assortment results in the use of sets of from two to three ounces in weight, and a set of less than two ounces is as often planted as one exceeding three or four ounces.

Our primary question is whether an increase in the size of the set will produce an excess above the extra weight of the sets planted; such extra weight going to increase the strength of the individual sets without increasing their number?

The unequivocal results in favour of large sets, obtained from my experiments carried out in 1864, and recorded in the 'Gardener's Chronicle,' as well as from those which form the subject of this report, induce me to describe carefully the conditions under which the experiments were conducted.

Every precaution was taken to insure the most perfect uniformity in the conditions under which the various experiments were made. The manure was separately weighed out, and distributed on each 20 superficial feet of ground. The distance —2 feet—between the rows was the same throughout the trial ground; and to counteract the influence of any slight variations in the character of the soil, the particular experiments that would be brought into immediate comparison were placed as nearly as possible in juxtaposition. External rows were rejected for the experiments, and planted with part of the ordinary crop; and every individual set was separately weighed and selected to the specified size, and planted to measure, at precise distances.

Notwithstanding these precautions, there was a want of correspondence in many of the individual results, which I would notice as a warning against depending on the evidence of single experiments: for instance, in plots planted under precisely the same conditions, and with no apparent difference in the appearance of the crops, the produce varied to the extent of several tons per acre. Similar inequalities, apparently unaccountable, will be found in all agricultural crops, and in the conduct of experiments every care should be taken that they are fully recognized in the calculation of results.

Under the head of "Accidental Variations of Result" at the end of the report, I shall consider this subject more in detail, and endeavour to show the extent to which these adventitious irregularities affect the general tenor of the experiments.

It remains now to consider separately the various points to which the experiments relate.

It will be found that I have in no case relied on isolated results, but drawn the conclusions from the general bearing of the series. Throughout the report the term "Gross Crop" will apply to the whole weight of potatoes produced per acre, and "Net Crop" to the balance of produce after deducting the weight of the sets from which it was grown.

Firstly. The influence of the size of the set on the economic results of the crop; or whether any increase, and to what extent, is

obtained over and above the increased weight of the set in the planting of large in the lieu of small sets.

Several separate series of experiments may be cited in evidence of the influence of the weight of the set on the produce of the crop. An average of from ten to thirteen experiments with different varieties, planted one foot apart in the rows, gave the following results:—

Gross Returns per Acre.

				tons.	cwts.	qrs.	lbs.	ozs.
Average of	13 varieties,	1 oz. sets	..	10	19	3	17	or 17·65 per set.
„	13 „	2 oz. sets	..	12	15	2	14	or 21·03 „
„	12 „	4 oz. sets	..	15	17	2	15½	or 25·39 „
„	9 „	6 oz. sets	..	20	6	1	9	or 33·44 „
„	6 „	8 oz. sets	..	23	8	1	14	or 38·67 „

After deducting the weight of the sets, the net balances of produce per acre will stand as follows:—

				tons.	cwts.	qrs.	lbs.	ozs.
Average of	13 varieties,	1 oz. sets	..	9	17	3	0	or 16·65 per set.
„	13 „	2 oz. sets	..	11	11	1	7½	or 19·03 „
„	12 „	4 oz. sets	..	13	9	0	2½	or 21·39 „
„	9 „	6 oz. sets	..	16	13	1	16½	or 27·44 „
„	6 „	8 oz. sets	..	18	11	0	16	or 30·67 „

The following are the amounts of *net* profit per acre for *each oz.* in the increase in the weight of the sets, from 1 oz. up to 8 ozs. (each oz. in the weight of the set occupying 2 square feet, being equivalent to 12 cwts. 17½ lbs. per acre) of seed:—

	tons.	cwts.	qrs.	lbs.
From 1 to 2 ozs.	1	13	2	7½
„ 2 to 4 ozs., for each extra oz.	0	18	3	14
„ 4 to 6 ozs. „	1	12	0	21
„ 6 to 8 ozs. „	0	18	3	14

The average of a number of experiments with different varieties planted 9 inches apart in the rows, gave very similar results as follows:—

Gross Returns per Acre.

				tons.	cwts.	qrs.	lbs.	ozs.
Average of	11 varieties,	1 oz. sets	..	10	12	0	23	or 14·21 per set.
„	12 „	2 oz. sets	..	15	2	2	11	or 18·45 „
„	6 „	4 oz. sets	..	17	17	3	12	or 21·99 „

After deducting the weight of the sets, the net balances of produce per acre stand thus:—

				tons.	cwts.	qrs.	lbs.	ozs.
Average of	11 varieties,	1 oz. sets	..	9	16	0	0	or 13·21 per set.
„	12 „	2 oz. sets	..	13	10	0	21	or 16·45 „
„	6 „	4 oz. sets	..	14	13	0	4	or 17·99 „

The average produce of a number of varieties planted at

intervals of 6 inches in the row, also exhibited similar advantages in favour of the larger sets, viz. :—

Gross Returns per Acre.

				tons.	cwts.	qrs.	lbs.	ozs.
Average of 11 varieties,		1 oz. sets	..	13	4	1	20	or 10·85 per set.
„	10 „	2 oz. sets	..	15	19	0	12	or 13·15 „
„	3 „	4 oz. sets	..	22	0	2	3	or 18·11 „

After deducting the weight of the sets the net balances of produce per acre stand thus :—

				tons.	cwts.	qrs.	lbs.	ozs.
Average of 11 varieties,		1 oz. sets	..	12	0	0	13½	or 9·85 per set.
„	10 „	2 oz. sets	..	13	10	1	27	or 11·15 „
„	3 „	4 oz. sets	..	17	3	1	5	or 14·11 „

Every step in each of these three series of experiments gives, without an exception, unequivocal evidence that each increase in the weight of the set produces more than a corresponding increase in the weight of the crop. The following statement will, however, shew that the advantage in the employment of large sets is much less striking in the early than in the late varieties; out of the examples before given the produce of the early varieties, planted one foot apart in the row, exhibit the following result :—

			Gross Crop.				Net.			
			tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.
Average of 7 early varieties,		1 oz. sets	9	3	3	26	8	11	3	8¾
„	7 „	2 oz. sets	10	14	2	17	9	10	1	10½
„	6 „	4 oz. sets	13	19	0	7½	11	10	1	22½
„	6 „	6 oz. sets	15	6	0	22	11	13	1	2½
„	2 „	8 oz. sets	7	17	0	21	2	19	3	23

Although there is throughout an increase over and above the extra weight of the sets, the advance between the larger sizes is not very marked, and is much below that wherein the early and late sets are averaged together. There is even a falling off in the produce of the 8 oz. sets, in comparison with those weighing 6 ozs.; but this is partly from accidental circumstances; the 8 oz. sets being much sprouted before planting, indeed all the larger sets of the early varieties were much more advanced than those of smaller size. After separating the early sorts from the general average results of early and late, given at page 554 the average produce of the late varieties, taken separately, will stand as follows :—

			Gross.				Net.			
			tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.
Average of 6 late varieties,		1 oz. sets	12	0	0	15	11	7	3	26
„	6 „	2 oz. sets	15	3	1	19	13	19	0	13
„	6 „	4 oz. sets	17	16	0	24	15	7	2	11
„	3 „	6 oz. sets	30	6	2	11	26	13	2	19
„	4 „	8 oz. sets	31	3	3	24	26	6	2	26

Secondly. As to the influence on the crop of the distance at which the sets are planted; or the results of close and wide planting of various sized sets.

To establish this point, I shall compare, *separately*, each series of experiments on potatoes *of the same weight*, planted at different distances:—

Averages of 1 oz. Sets.

	Gross. tons.	cwts.	qrs.	lbs.	Net. tons.	cwts.	qrs.	lbs.
13 varieties, planted 1 foot apart ..	10	9	3	17	9	17	3	0
11 „ 9 inches apart	10	12	0	23	9	16	0	0
11 „ 6 inches apart	13	4	1	20	12	0	0	13

Averages of 2 oz. Sets.

	Gross. tons.	cwts.	qrs.	lbs.	Net. tons.	cwts.	qrs.	lbs.
13 varieties, planted 1 foot apart ..	12	15	2	4	11	11	1	7
12 „ 9 inches apart	15	15	2	11	13	10	0	21
10 „ 6 inches apart	15	19	0	12	13	10	1	27

Averages of 4 oz. Sets.

	Gross. tons.	cwts.	qrs.	lbs.	Net. tons.	cwts.	qrs.	lbs.
12 varieties, planted 1 foot apart ..	15	17	2	15½	13	9	0	2½
6 „ 9 inches apart	17	17	3	12	14	13	0	4
3 „ 6 inches apart	22	0	2	3	17	3	1	5

Averages of 4 oz. Sets (similar varieties).

	Gross. tons.	cwts.	qrs.	lbs.	Net. tons.	cwts.	qrs.	lbs.
3 varieties, planted 1 foot apart ..	15	8	3	24	13	0	1	11
3 „ 9 inches apart	15	19	2	14	12	14	3	6
3 „ 6 inches apart	22	0	2	3	17	3	1	5

These comparisons all shew an advantage in planting the smaller sets at intervals closer than 12 inches in the rows; but the results are not very decided, and in one or two cases the gain in the gross crop does not make up for the extra weight of the sets planted.

The following comparisons refer to the effect of planting the sets more than a foot apart in the rows.

Three experiments averaged together, viz.—

8 oz. "Flukes," 6 oz. "Flukes," and 4 oz. "Late Red," gave a gross crop of 23 tons 16 cwts. 1 qr. 8 lbs., and a net average of 20 tons 3 cwts. 1 qr. 17 lbs. The same sizes and varieties, planted at intervals in the rows of 1 foot 3 inches, produced a gross crop of 18 tons 13 cwts. 1 qr. 2 lbs., and a net crop of 15 tons 14 cwts. 3 qrs. 20 lbs.—a falling off of 4 tons 8 cwts. 1 qr. 25 lbs. per acre. Indeed the produce of each set was, as nearly as possible, the same, whether planted a foot apart or 15 inches, so that the additional distance was so much loss to the crop. The average produce of 6 oz. and 8 oz. Flukes shews

a similar falling off when planted more than a foot apart in the rows:—

	tons.	cwts.	qrs.	lbs.	
Flukes, at 1 foot, the net average produce was ..	17	10	1	25	per acre.
Flukes, at 1 foot 3 inches „ ..	15	8	2	6½	„
Flukes, at 1 foot 6 inches „ ..	12	16	0	5	„

This diminution of the crop, through reducing the number of the sets per acre, is remarkably uniform, and as nearly as possible proportionate to the distance at which the sets are planted.

The general tenor of these experiments points to an interval of 10 or 12 inches in the rows, as being the most profitable distance at which to plant large full-sized potatoes, of from 4 to 8 ozs. in weight. A moderate increase in the net-crop may be expected from still further diminishing the distance when the sets are below 4 ozs. in weight; but this point will be again referred to in considering

Thirdly. The comparative results obtained from planting equal weights of large and small Potatoes respectively.

In the previous series of comparisons (1) the advantage of large over small sets, placed at similar distances, was very striking, large sets producing a much greater crop than an equal *number* of small sets on the same area, and the crop bearing a very regular proportion to the weight of the individual sets. We have now to ascertain whether by diminishing the distance and increasing the number of small sets an equivalent can be obtained for the increased individual productiveness of larger sets.

1 ton 4 cwts. 1 qr. 6 lbs. of sets per acre, planted as—

	Per Acre. tons.	cwts.	qrs.	lbs.
2 oz. sets, 1 foot apart, gave, on a number of experiments, a net average produce of	11	11	1	7
And as 1 oz. sets, 6 inches apart	12	0	0	13
Balance in favour of small sets at close intervals of ..	0	8	3	6

2 tons 8 cwts. 2 qrs. 13 lbs. weight of sets per acre, averaging a number of experiments, planted—

	Per Acre. tons.	cwts.	qrs.	lbs.
As 4 oz. sets, 1 foot apart, produced a net return of ..	13	9	0	2½
As 2 oz. sets, 6 inches apart	13	10	1	27
Balance in favour of small sets at close intervals of ..	0	1	1	24½

4 tons 17 cwts. 26 lbs. planted—

	Per Acre. tons.	cwts.	qrs.	lbs.
As 8 oz. sets, 1 foot apart, produced a net return of ..	18	11	0	16
As 4 oz. sets, 6 inches apart	17	3	1	5
Balance in favour of large sets at wide intervals of ..	1	7	3	11

3 tons 4 cwts. 3 qrs. 8 lbs. weight of Fluke sets per acre, planted—

	Per Acre. tons.	cwts.	qrs.	lbs.
As 8 oz. sets, 1 foot 6 inches apart, produced a net return of	12	3	0	9
As 4 oz. sets, 9 inches apart	13	4	2	6
Balance in favour of small sets at close intervals of ..	1	1	1	25

These balances are so small, that they can scarcely be relied on as indicating any decided advantage in either direction; but the nearly equal results of the experiments point conclusively to the fact of ·he very regular ratio borne between the weights of the crop and the weights per acre of the sets, a ton of sets, whether planted as large or small potatoes, producing the same weight of crop per acre. It must, however, be observed that, *practically*, the principle is only of limited application. Taking 1 foot as the maximum, and 6 inches as the minimum distance between the sets in the rows, it will be easily understood that a weight of small sets, say of 1 or 2 ozs., equivalent to large sets of 6 or 8 ozs., could not be got into the ground, therefore the general principle, that the crop varies as the weight of the sets, weight for weight, is not practically applicable where the sets differ in weight beyond the proportion of 1 to 2. Small sets, therefore, of 1 to 3 ozs., can, under no arrangement, produce as much per acre as sets of from 4 to 8 ozs.

Fourthly. As to the relative advantages of cut and whole sets.

A comparison may be instituted between the average results of five experiments with sets formed by dividing large potatoes, and five experiments with whole potatoes weighing the same as the cut half sets.

Cut Potatoes.

	Net Balances. tons.	cwts.	qrs.	lbs.
Flukes, 4 ozs., cut out of 8 oz. potatoes, 1 foot apart, produced	12	2	0	23
Flukes, 4 ozs., cut out of 8 oz. potatoes, 9 inches apart, produced	14	10	2	4
Flukes, 2 ozs., cut out of 4 oz. potatoes, 1 foot apart, produced	10	4	0	21
Flukes, 2 ozs., cut out of 4 oz. potatoes, 9 inches apart, produced	11	13	1	12
Flukes, 2 ozs., cut out of 4 oz. potatoes, 6 inches apart, produced	8	6	2	1
ate Red, 2 ozs., cut out of 4 oz. potatoes, 1 foot apart, produced	23	7	1	0
Aggregate on six acres of	80	4	0	5
Average per acre	13	7	1	10

Whole Potatoes.

	Net. Balances. tons.	cwts.	qrs.	lbs.
Flukes, 4 oz. sets, 1 foot apart, produced	13	3	3	23
Flukes, 4 oz. sets, 9 inches apart, produced	13	4	2	6
Flukes, 2 oz. sets, 1 foot apart, produced	7	5	0	27
Flukes, 2 oz. sets, 9 inches apart, produced	5	12	3	17
Flukes, 2 oz. sets, 6 inches apart, produced	7	10	2	23
Late Red, 2 oz. sets, 1 foot apart, produced	30	15	2	26½
Aggregate on six acres of	77	13	0	10½
Average per acre	12	18	3	11

Showing an average balance in favour of the cut sets over an equal weight per acre of whole sets of about 8½ cwts. per acre.

In another instance

	tons.	cwts.	qrs.	lbs.
Flukes, 3 oz. sets, cut out of 6 oz. sets, 9 inches apart, gave	14	8	1	23
And Flukes, 6 oz., uncut, planted 1 foot 6 inches apart ..	13	9	0	1
Showing a net balance in favour of the cut sets of ..	0	19	1	22

Both these comparative series indicate a slight advantage in favour of the cut sets; but since the individual experiments do not all point in the same direction, the result of the series cannot be looked upon as at all decisive; but it rather tends to the conclusion previously indicated, that the *weight per acre* of the sets planted has more to do with the produce of the crop than any other circumstance.

Fifthly. As to the influence of thick and thin planting, and of the size of the set on the proportion borne between the weight of the sets and their individual produce, and the rate of increase under various conditions.

This subject presents itself under yet another aspect, which interests the physiologist rather than the farmer, viz., the proportion borne between the weight of the sets and the weight of the crop, or, in other words, the rate of increase. This rate, as was to be expected, is larger as the sets are smaller and as the distance is greater, up to 1 foot apart, beyond which space no perceptible change takes place.

On the general average of these experiments—

The 1 oz. sets increased	14·24 fold
The 2 oz. "	8·77 "
The 4 oz. "	5·87 "
The 6 oz. "	5·81 "
The 8 oz. "	4·83 "

At 1 foot interval, the 1 oz., 2 oz., and 4 oz. sets increased	11·50 fold
At 9 inches " " "	9·64 "
At 6 inches " " "	7·73 "

The rate of progression was found to be very regular, both in individual experiments, and in average results.

Sixthly. As to the relative productiveness of different varieties of the Potato.

To avoid undue complication, the varieties employed in these experiments have been rather limited, and the question of their relative productiveness has only been a matter of secondary importance. As, however, several of the varieties are very generally cultivated, it may be well briefly to state the results.

The average produce of 1 oz., 2 oz., and 4 oz. sets planted 1 foot apart in the rows was as follows on the gross crop per acre :—

	tons.	cwts.	qrs.	lbs.
Late Red	27	10	3	8½
Spencer's King of Flukes	19	13	2	17
Second's Kidney	16	0	3	12
Daintree's Seedling	15	8	1	25
Queen of Flukes	15	3	0	7
Flour-ball	14	2	1	23
"Vite-lots" (French Kidney)	13	6	3	19
Flukes	10	0	1	19
Early Handsworth	6	18	1	23
Early Prolific Kidney	4	14	1	18

The average produce of four series of experiments, viz., 1 oz. and 2 oz. planted at 9 inch intervals, and 1 oz. and 2 oz. at 6 inch intervals, stand in the following order :—

	tons.	cwts.	qrs.	lbs.
Late Red	27	9	1	20½
Spencer's King of Flukes	24	4	2	24
Daintree's Seedling	15	13	0	0
Flour-ball	14	18	3	20
Queen of Flukes	14	15	3	11½
Second's Kidney	14	9	3	3
Lapstones	11	4	3	5
Early Handsworth	7	14	2	17
Flukes	7	6	0	3
Lemon Kidney	7	4	1	20
Early Prolific Kidney	6	12	2	18

The crops produced from 6 oz. sets planted 1 foot apart, stand in the following order of productiveness :—

	tons.	cwts.	qrs.	lbs.
Late Red	37	18	3	0
Spencer's King of Flukes	30	19	3	12
Second's Kidney	26	8	2	22
Daintree's Seedling	25	16	2	5
Flukes	22	1	0	21
Early Handsworth	13	16	2	0
"Vite-lots" (French Kidney)	13	8	1	8
Lapstones	11	19	0	3
Early Prolific Kidney	7	9	3	17

Of "The Queen of Flukes" and "Flour-ball," there were no experiments with 6 oz. sets.

The relative productiveness of the several varieties grown from 8 oz. sets, planted at intervals of 12 inches, stand thus:—

	tons.	cwts.	qrs.	lbs.
Late Red	38	19	2	25
Spencer's King of Flukes	34	0	2	14
Queen of Flukes	30	5	2	9
Flukes	21	9	3	19
Lapstones	4	17	0	26
Early Prolific Kidney	3	15	1	11

The above four series of comparisons are tolerably uniform, as expressing the relative productiveness of the varieties they include. The actual order of precedence of some of the individual varieties, that do not differ much in their produce, varies a little; but the relative positions are in general uniform; the late red in each set of experiments produced the heaviest crop; and the Early Prolific Kidney appears in every case at the bottom of the list.

Of the three varieties of Fluke, the greater productiveness of both Spencer's King and the Queen of Flukes, than that of the ordinary variety, is very noticeable; Spencer's King especially, throughout the series, producing from half as much more, to twice as much as the Common Fluke, not only in the general averages, but in all the individual experiments.

Seventhly. Accidental variations of Result.

It has been necessary, in drawing our conclusions, to altogether avoid relying on the results of isolated experiments. Whatever precautions may be taken to ensure uniformity in the conditions under which agricultural experiments are conducted, unaccountable anomalies in the result will be found to occur; variations which affect all agricultural crops, and which should be fully recognised and guarded against when inferences are drawn from experiments.

The only way to remove such sources of error is to throw together the average results of a number of independent experiments, so that the irregularities tending in either direction may neutralise each other. I would cite, by way of illustration, the individual trials making up the average results given under the first head.

At page 554 it was stated that the *average* balance on 13 experiments, in favour of 2 oz. over 1 oz. sets, was 1 ton 13 cwt. 2 qrs. 7½ lbs. per acre; but if we come to details, it appears that, out of these 13 experiments, 5 show a result in favour of the 1 oz. sets, and 8 in favour of the 2 oz. This proportion, 8 to 5, taken by itself, is not very striking, and might be accidental; but when the sum of the weights of the gains in favour of the

larger sets is placed against that in favour of the smaller sets, the proportion is increased to 25 to 5.

	Net Balances. tons.	cwts.	qrs.	lbs.
The gains per acre on 8 experiments, in favour of 2 oz. sets over 1 oz. sets, is	27	8	3	22½
Whilst the gain on 5 experiments, in favour of 1 oz. sets, is but	5	12	2	6¼
Leaving a balance in favour of 2 oz. over 1 oz. of	21	16	1	16¼

or 1 ton 13 cwt. 2 qrs. 7½ lbs. per acre.

Even this result taken singly might be merely accidental; but when the other steps in the same series show precisely similar tendencies, the general tenor must be accepted as confirming the indications given by the majority of the individual experiments.

In comparing the produce of 2 oz. and 4 oz. sets, out of 12 experiments, the net results of 8 are in favour of the 4 oz. sets, and 4 in favour of the 2 oz.

	Net Balances. tons.	cwts.	qrs.	lbs.
The gains per acre on the 8 experiments, in favour of the 4 oz. sets, amount to	28	19	3	2½
And those on the 4 experiments, in favour of the 2 oz. sets	9	15	2	11½
Leaving a balance in favour of the 4 oz. over the 2 oz. sets of	19	4	0	19

or 1 ton 12 cwts. 0 qrs. 1½ lbs. per acre.

In comparing the produce of 4 oz. and 6 oz. sets, out of 9 experiments, 7 are in favour of the larger sets, and 2 of the smaller.

	Net Balances. tons.	cwts.	qrs.	lbs.
The gains per acre on the 7 experiments, in favour of the 6 oz. sets, amounted to..	30	0	2	15¾
Those on the 2 experiments, in favour of the 4 oz. sets, to	12	12	2	10¾
Leaving a balance in favour of the 6 oz. over the 4 oz. sets of	17	8	0	5

averaging 1 ton 18 cwts. 2 qrs. 19 lbs. per acre net.

Advancing from 6 to 8 oz. sets, out of 5 experiments 2 are in favour of 8 oz., and 3 in favour of 6 oz. sets.

	Net Balances. tons.	cwts.	qrs.	lbs.
The sum of the gains per acre on 2 experiments, in favour of 8 oz. sets, amounted to	7	13	3	22
And those on 3 experiments, in favour of 6 oz. sets, amounted to	6	17	2	27
Leaving a net balance in favour of 8 oz. over 6 oz. sets, of	0	16	0	23

on 5 experiments, averaging 3 cwts. 0 qrs. 27 lbs. per acre.

Of the whole series of 39 experiments, 25 were in favour of large sets, and 14 showed an opposite tendency; but the proportion borne between these numbers does not fully represent the actual result, which is more fairly stated by the weights of the balances on either side; for whilst the gains on the 25 (acres) experiments calculated per acre amounted to 94 tons 3 cwt. 1 qr. 6½ lbs. in favour of large sets, the gain (14 acres) on the 14 experiments favourable to the smaller sets amounted to only 34 tons 17cwt. 1 qr. 27½ lbs., leaving (after setting the gains against the losses) an average net balance, on the 39 comparisons, of more than 1 ton 10 cwt. in favour of the larger sets on each advance, namely, from 1 to 2 ozs., from 2 to 4 ozs., from 4 to 6 ozs., and from 6 to 8 ozs. I have been particular in noticing these exceptional irregularities, and their general bearing on the tenor of the experiments, as an element inseparable from agricultural experiments, and as requiring the fullest recognition in the estimation of results.

It now only remains briefly to recapitulate the general bearing of the experiments, the results of which have been described in detail.

Firstly. Every increase in the size of the set, from 1 oz. up to 8 ozs. in weight, produces an increase in the crop much greater than the additional weight of the set planted. *The net profit* over and above the extra weight of the sets in planting 4 oz. sets in lieu of 1 oz. sets, amounted on the whole series of experiments to between 3 and 4 tons per acre; and the further *profit* on the increase of the size of the set from 4 ozs. to 8 ozs., averaged about 5 tons an acre; all the intermediate steps partaking proportionately of the increase.

Secondly. The advantages in favour of the large sets is more marked in the late than in the early varieties.

Thirdly. In the use of small sets of from 1 oz. to 3 ozs. in weight, a larger balance over and above the weight of the sets was obtained by planting from 6 to 9 inches apart in the rows than at wider intervals.

Fourthly. Increasing the intervals at which the sets are planted, even of the largest size, in the rows to more than 12 inches, diminishes the crop, and the wider intervals induce no increase in the weight of the produce of the individual sets.

Fifthly. It may be broadly stated that the weight of the crop is proportionate to the weight per acre of the sets, and that small sets will produce the same crop as an *equal weight per acre* of large sets. The fact is, however, of limited application, as a weight of very small sets equal to a weight of full-sized potatoes could not be got into the ground, except by planting them so close

TABLE 1.—RESULTS of EXPERIMENTS on the POTATO-CROP,

No.	Variety of Potato.	When Planted.	Manure and Remarks.	Distance in the Row.
				ft. in.
1	Early Prolific ..	March 2	20 tons of stable manure per acre	1 0
2	Early Prolific ..	,, 2	Ditto ditto	0 9
3	Early Prolific ..	,, 2	Ditto ditto	0 6
4	Early Prolific ..	,, 1	Ditto ditto	1 0
5	Early Prolific ..	,, 2	Ditto ditto	0 9
6	Early Prolific ..	,, 2	Ditto ditto	0 6
7	Early Prolific ..	,, 1	Ditto ditto	1 0
8	Early Prolific ..	,, 1	Ditto ditto	0 9
9	Early Prolific ..	,, 1	Ditto ditto	0 6
10	Early Prolific ..	,, 1	Ditto, sets much sprouted	1 0
11	Early Prolific ..	,, 1	Ditto, sets much sprouted	1 0
12	Flukes	,, 8	20 tons of stable manure per acre	1 0
13	Flukes	,, 8	Ditto ditto	0 9
14	Flukes	,, 8	Ditto ditto	0 6
15	Flukes	,, 7	Ditto ditto	1 0
16	Flukes	,, 7	Ditto ditto	0 9
17	Flukes	,, 7	Ditto ditto	0 6
18	Flukes	,, 8	Ditto ditto	1 0
19	Flukes	,, 7	Ditto ditto	0 9
20	Flukes	,, 7	Ditto ditto	0 6
21	Flukes	,, 9	Ditto, and 4 cwts. dried blood	1 0
22	Flukes	,, 9	Ditto, and 4 cwts. muriate of potash ..	1 0
23	Flukes	,, 8	Ditto, and 4 cwts. guano	1 0
24	Flukes	,, 8	Ditto, and 4 cwts. mineral superphosphate	1 0
25	Flukes	,, 9	Ditto, and 4 cwts. sulphate of ammonia	1 0
26	Flukes	,, 7	20 tons of stable manure per acre	1 0
27	Flukes	,, 9	Ditto, and 4 cwts. dried blood	1 0
28	Flukes	,, 9	Ditto, and 4 cwts. muriate of potash ..	1 0
29	Flukes	,, 8	Ditto, and 4 cwts. guano	1 0
30	Flukes	,, 8	Ditto, and 4 cwts. mineral superphosphate	1 0
31	Flukes	,, 8	Ditto, and 4 cwts. sulphate of ammonia	1 0
32	Flukes	,, 7	20 tons stable manure per acre	1 0
33	Flukes	,, 7	Ditto ditto	1 3
34	Flukes	,, 7	Ditto ditto	1 6
35	Flukes	,, 7	Ditto ditto	1 3
36	Flukes	,, 7	Ditto ditto	1 6
37	Flukes cut out of 8 oz. sets	,, 7	Ditto ditto	1 0
38	Flukes cut out of 8 oz. sets	,, 7	Ditto ditto	0 9
39	Flukes cut out of 6 oz. sets	,, 7	Ditto ditto	0 9
40	Flukes cut out of 4 oz. sets	,, 7	Ditto ditto	1 0
41	Flukes cut out of 4 oz. sets	,, 7	Ditto ditto	0 9
42	Flukes cut out of 4 oz. sets	,, 7	Ditto ditto	0 6
43	Spencer's King ..	,, 7	Ditto ditto	1 0
44	Spencer's King ..	,, 7	Ditto ditto	0 9
45	Spencer's King ..	,, 7	Ditto ditto	0 6
46	Spencer's King ..	,, 7	Ditto ditto	1 0

at Benthall, near Broseley, in 1865—rows all 2 feet apart.

Number of Sets per Acre.	Weight of Sets per Acre.				Gross produce per Acre.				Net produce per Acre after deducting weight of Sets.				Produce per Set stated in ozs.	Increase of Crop in proportion to the weight of Sets.
	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.		fold.
21,780	0	12	0	17¼	4	6	0	1	3	13	3	12	7·07	7·07
29,040	0	16	0	23	6	8	1	15½	5	12	0	20	9·30	9·30
43,560	1	4	1	6	5	19	3	16	4	15	2	10	4·92	4·92
21,780	1	4	1	6	4	12	2	25	3	8	1	19	7·62	3·81
29,040	1	12	1	18	5	14	1	0	4	1	3	10	7·05	3·52
43,560	2	8	2	13	8	8	0	12	5	19	1	27	7·21	3·56
21,780	2	8	2	13	5	4	2	2	2	13	3	17	8·57	2·14
29,040	3	4	3	8	9	13	0	13	6	8	1	5	11·91	2·97
43,560	4	17	0	26	13	17	3	5	9	0	2	7	11·42	2·85
21,780	3	12	3	19½	7	9	3	17	3	16	3	23½	12·33	2·05
21,780	4	17	0	26	3	15	1	11		..		..	6·20	0·77
21,780	0	12	0	17½	5	19	0	12	5	6	3	23	9·80	9·80
29,040	0	16	0	23	5	12	2	5	4	16	1	10	7·00	7·00
43,560	1	4	1	6	6	16	3	20	5	12	2	4	5·63	5·63
21,780	1	4	1	6	8	9	2	5	7	5	0	27	13·95	6·97
29,040	1	12	1	18	6	15	1	7	5	12	3	17	8·35	4·17
43,560	2	8	2	13	9	19	1	8	7	10	2	23	8·20	4·10
21,780	2	8	2	13	15	12	2	12	13	3	3	27	25·72	6·43
29,040	3	4	3	8	16	9	1	14	13	4	2	6	20·32	5·08
43,560	4	17	0	26	21	18	0	24	17	0	3	2	18·02	4·50
21,780	2	8	2	13	11	1	3	22	8	13	1	9	18·26	5·65
21,780	2	8	2	13	15	17	1	3	13	8	2	18	26·58	6·64
21,780	2	8	2	13	7	12	3	13	5	4	1	0	12·57	3·14
21,780	2	8	2	13	12	3	1	11	9	14	2	26	18·88	4·72
21,780	2	8	2	13	11	8	2	15	9	0	0	2	18·81	4·71
21,780	3	12	3	20	22	1	0	21	18	8	1	1	36·80	6·05
21,780	3	12	3	20	12	6	0	13	8	13	0	21	20·25	3·37
21,780	3	12	3	20	15	8	1	17	11	15	1	25	25·37	4·22
21,780	3	12	3	20	12	7	1	2	8	14	1	10	20·34	3·32
21,780	3	12	3	20	14	2	2	9	10	9	2	17	23·25	3·87
21,780	3	12	3	20	15	16	2	1	12	3	2	9	26·04	4·34
21,780	4	17	0	26	21	9	3	19	16	12	2	21	36·20	4·52
17,424	3	17	3	4	20	10	3	6	16	13	0	2	42·25	5·28
14,520	3	4	3	8	15	7	3	17	12	3	0	9	38·00	4·75
17,424	2	18	1	10	17	2	1	21	14	4	0	11	35·21	5·86
14,520	2	8	2	13	15	17	2	14	13	9	0	1	39·21	6·53
21,780	2	8	2	13	14	10	3	8	12	2	0	23	23·92	5·98
29,040	3	4	3	8	17	15	1	12	14	10	2	4	21·92	5·48
29,040	2	8	2	13	16	17	0	8	14	8	1	23	20·80	6·93
21,780	1	4	1	6	11	8	1	27	10	4	0	21	18·80	9·40
29,040	1	12	1	18	13	5	3	2	11	13	1	12	16·40	8·20
43,560	2	8	2	13	10	15	0	14	8	6	2	1	13·85	6·92
21,780	0	12	0	17	15	16	1	3	15	4	0	14	26·00	18·74
29,040	0	16	0	23	19	4	0	7	18	7	3	12	23·70	23·70
43,560	1	4	1	6	20	19	1	7	19	15	0	0	17·25	17·25
21,780	1	4	1	6	17	14	3	16	16	10	2	9	29·20	14·50

TABLE 1.—RESULTS of EXPERIMENTS on the POTATO-CROP, made at

No.	Variety of Potato.	When Planted.	Manure and Remarks.	Distance in the Row.
				ft. in.
47	Spencer's King ..	March 7	20 tons of stable manure per acre	0 9
48	Spencer's King ..	,, 7	Ditto ditto	0 6
49	Spencer's King ..	,, 7	Ditto ditto	1 0
50	Spencer's King ..	,, 7	Ditto ditto	0 9
51	Spencer's King ..	,, 7	Ditto ditto	0 6
52	Spencer's King ..	,, 6	Ditto ditto	1 0
53	Spencer's King ..	,, 6	Ditto ditto	1 0
54	Queen of Flukes	,, 6	Ditto ditto	1 0
55	Queen of Flukes	,, 6	Ditto ditto	0 9
56	Queen of Flukes	,, 6	Ditto ditto	0 6
57	Queen of Flukes	,, 6	Ditto ditto	1 0
58	Queen of Flukes	,, 6	Ditto ditto	0 9
59	Queen of Flukes	,, 6	Ditto ditto	0 6
60	Queen of Flukes	,, 6	Ditto ditto	1 0
61	Queen of Flukes	,, 6	Ditto ditto	0 9
62	Queen of Flukes	,, 6	Ditto ditto	1 0
63	Flour Ball	,, 6	Ditto ditto	1 0
64	Flour Ball	,, 6	Ditto ditto	0 9
65	Flour Ball	,, 6	Ditto ditto	0 6
66	Flour Ball	,, 6	Ditto ditto	1 0
67	Flour Ball	,, 6	Ditto ditto	0 9
68	Flour Ball	,, 6	Ditto ditto	0 6
69	Flour Ball	,, 6	Ditto ditto	1 0
70	Second Kidney ..	,, 4	Ditto ditto	1 0
71	Second Kidney ..	,, 4	Ditto ditto	0 9
72	Second Kidney ..	,, 4	Ditto ditto	0 6
73	Second Kidney ..	,, 4	Ditto ditto	1 0
74	Second Kidney ..	,, 4	Ditto ditto	0 9
75	Second Kidney ..	,, 4	Ditto ditto	0 6
76	Second Kidney ..	,, 4	Ditto ditto	1 0
77	Second Kidney ..	,, 4	Ditto ditto	1 0
78	Daintree's Seedling	,, 3	Ditto ditto	1 0
79	Daintree's Seedling	,, 3	Ditto ditto	0 9
80	Daintree's Seedling	,, 3	Ditto ditto	0 6
81	Daintree's Seedling	,, 3	Ditto ditto	1 0
82	Daintree's Seedling	,, 3	Ditto ditto	0 9
83	Daintree's Seedling	,, 3	Ditto ditto	0 6
84	Daintree's Seedling	,, 3	Ditto ditto	1 0
85	Daintree's Seedling	,, 3	Ditto ditto	1 0
86	Early Handsworth	,, 3	Ditto ditto	1 0
87	Early Handsworth	,, 3	Ditto ditto	0 9
88	Early Handsworth	,, 3	Ditto ditto	0 6
89	Early Handsworth	,, 3	Ditto ditto	1 0
90	Early Handsworth	,, 3	Ditto ditto	0 9
91	Early Handsworth	,, 3	Ditto ditto	1 0
92	Early Handsworth	,, 3	Ditto ditto	1 0
93	Lemon Kidney ..	,, 3	Ditto ditto	1 0
94	Lemon Kidney ..	,, 3	Ditto ditto	0 9
95	Lemon Kidney ..	,, 3	Ditto ditto	0 6
96	Lemon Kidney ..	,, 3	Ditto ditto	1 0
97	Lemon Kidney ..	,, 3	Ditto ditto	0 9
98	Lemon Kidney ..	,, 3	Ditto ditto	0 6

ll, near Broseley, in 1865—rows all 2 feet apart—*continued.*

umber f Sets r Acre.	Weight of Sets per Acre.				Gross produce per Acre.				Net produce per Acre after deducting weight of Sets.				Produce per Set stated in ozs.	Increase of Crop in proportion to the weight of Sets.
	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.		fold.
)9,040	1	12	1	18	35	8	0	19	33	15	3	1	43·70	21·85
3,560	2	8	2	13	21	7	1	9	18	18	2	24	17·58	8·79
1,780	2	8	2	13	25	9	3	3	23	1	0	18	44·00	11·00
9,040	3	4	3	8	21	16	1	15	18	11	2	7	27·00	6·73
3,560	4	17	0	26	30	5	2	9	25	8	1	11	24·91	6·25
1,780	3	12	3	19	30	19	3	12	27	6	3	20	51·00	8·50
1,780	4	17	0	26	34	0	2	14	29	3	1	16	56·00	7·00
1,780	0	12	0	18	14	6	2	6	13	14	1	17	24·40	24·40
9,040	0	16	0	23	10	14	2	24	9	18	2	1	13·25	13·25
3,560	1	4	1	6½	15	16	0	0½	14	11	2	22	13·40	13·00
1,780	1	4	1	6½	14	4	3	0	13	0	1	21	23·42	11·74
9,040	1	12	1	18	14	19	1	1	13	6	3	11	15·80	9·56
3,560	2	8	2	13	17	13	1	21	15	4	3	8	14·54	7·27
1,780	2	8	2	13	16	17	3	15	14	9	1	2	17·80	6·95
9,040	3	4	3	8	19	6	3	2	16	1	3	22	23·87	5·96
1,780	4	17	0	26	30	5	2	9	25	8	1	11	49·83	6·22
1,780	0	12	0	17	10	12	2	21	10	0	2	4	17·50	17·50
9,040	0	16	0	23	6	8	2	0	5	12	1	5	18·80	18·80
3,560	1	4	1	6½	15	19	3	6	14	15	1	27½	13·15	13·15
1,780	1	4	1	6½	14	13	2	2	13	9	0	23	24·15	12·07
9,040	1	12	1	18	16	12	0	23	14	19	3	5	20·50	10·25
3,560	2	8	2	13	20	15	0	24	18	6	2	11	17·08	8·54
1,780	2	8	2	13	17	1	0	20	14	12	2	7	28·00	7·01
1,780	0	12	0	17	9	15	1	2	9	3	0	13	16·07	16·06
9,040	0	16	0	23	12	13	2	12	11	17	1	17	15·65	15·65
3,560	1	4	1	6½	13	13	2	21	12	9	1	14½	11·26	11·26
1,780	1	4	1	6½	18	6	1	21	17	2	0	14½	30·15	15·07
9,040	1	12	1	18	17	9	3	10	15	17	1	20	21·58	10·79
3,560	2	8	2	13	14	1	3	25	11	13	1	12	11·60	5·80
1,780	2	8	2	13	20	0	3	12	17	12	0	27	32·10	8·02
1,780	3	12	3	19½	26	8	2	22	22	15	3	2½	43·50	7·25
1,780	0	12	0	17	11	8	3	16	10	16	2	27	18·83	18·83
9,040	0	16	0	23	13	2	2	3	12	6	1	8	16·20	16·20
3,560	1	4	1	6½	14	4	2	17	13	0	1	10½	10·68	10·68
1,780	1	4	1	6½	14	4	1	17	13	0	0	10½	23·40	11·70
9,040	1	12	1	18	16	3	0	3	14	10	2	12	19·93	9·96
3,560	2	8	2	13	19	1	3	7	16	13	0	22	15·70	7·85
1,780	2	8	2	13	20	12	0	14	18	3	2	1	33·90	8·47
1,780	3	12	3	19½	25	16	2	5	22	3	2	13	42·15	7·08
1,780	0	12	0	17¼	4	12	1	13½	4	0	0	24¼	7·60	7·60
9,040	0	16	0	23	7	16	1	15	7	0	0	20	9·65	9·65
3,560	1	4	1	6½	8	17	0	3	7	12	2	24½	7·65	7·65
1,780	1	4	1	6½	4	18	0	18	3	13	3	11½	8·07	4·04
9,040	1	12	1	18	6	10	2	5	4	18	0	15	8·05	4·02
1,780	2	8	2	13	11	4	3	11	8	16	0	26	17·66	4·62
1,780	3	12	3	19½	13	16	2	0	10	3	2	8½	22·75	3·79
1,780	0	12	0	17¼	6	19	2	27	6	7	2	10	11·50	11·50
9,040	0	16	0	23	7	18	0	0	7	1	3	5	9·75	9·75
3,560	1	4	1	6½	7	7	0	7	6	2	3	0½	6·05	6·05
1,780	1	4	1	6½	6	17	2	27½	5	13	1	21	11·33	5·66
9,040	1	12	1	18	8	11	3	3	6	19	1	13	10·60	5·30
3,560	2	8	2	13	5	0	3	14⅜	2	12	1	1⅜	4·15	2·07

TABLE 1.—RESULTS of EXPERIMENTS on the POTATO-CROP, made at

No.	Variety of Potato.	When Planted.	Manure and Remarks.		Distance in the Row.	
					ft.	in.
99	Lapstone	March 4	20 tons of stable manure per acre	.. ..	1	0
100	Lapstone	,, 4	Ditto	ditto	0	9
101	Lapstone	,, 4	Ditto	ditto	0	6
102	Lapstone	,, 4	Ditto	ditto	1	0
103	Lapstone	,, 4	Ditto	ditto	0	9
104	Lapstone	,, 4	Ditto	ditto	0	6
105	Lapstone	,, 4	Ditto	ditto	1	0
106	Lapstone	,, 4	Ditto	ditto	0	9
107	Lapstone	,, 4	Ditto	ditto	1	3
108	Lapstone	,, 4	Ditto	ditto	1	0
109	Lapstone	,, 4	Ditto	ditto	1	0
110	French Red Kidney	,, 6	Ditto	ditto	1	0
111	French Red Kidney	,, 6	Ditto	ditto	1	0
112	French Red Kidney	,, 6	Ditto	ditto	1	0
113	French Red Kidney	,, 6	Ditto	ditto	1	0
114	Blues	,, 8	Ditto	ditto	1	0
115	Blues	,, 8	Ditto	ditto	1	0
116	Blues	,, 8	Ditto	ditto	0	9
117	Blues	,, 8	Ditto	ditto	1	0
118	Late Red	,, 8	Ditto	ditto	1	0
119	Late Red	,, 8	Ditto	ditto	0	9
120	Late Red	,, 8	Ditto	ditto	0	6
121	Late Red	,, 8	Ditto	ditto	1	0
122	Late Red	,, 8	Ditto	ditto	0	9
123	Late Red	,, 8	Ditto	ditto	0	6
124	Late Red	,, 8	Ditto	ditto	1	0
125	Late Red	,, 8	Ditto	ditto	0	9
126	Late Red	,, 8	Ditto	ditto	1	3
127	Late Red	,, 8	Ditto	ditto	1	0
128	Late Red	,, 8	Ditto	ditto	1	0
129	Late Red cut out of 4 oz. sets ..	,, 8	Ditto	ditto	1	0

TABLE 2.—RESULTS of EXPERIMENTS on the

No.	Weight of Sets.	Name of Potato.	When Planted.	Distance in the Rows.		Number of Sets per Acre.	Weight of Sets per Acre.				Produce per Set in Ozs.
				ft.	in.		tons.	cwts.	qrs.	lbs.	
1	8 ozs.	Early Prolific Kidney	Feb. 16	1	0	21,780	4	17	0	26	28·17
2	4 ,,	Early Prolific Kidney	,,	1	0	21,780	2	8	2	13	23·21
3	2 ,,	Early Prolific Kidney	,,	1	0	21,780	1	4	1	6	17·07
4	4 ,,	Seconds Kidney ..	March 31	1	0	21,780	2	8	2	13	13·95
5	2 ,,	Seconds Kidney ..	,,	1	0	21,780	1	4	1	6	13·55
6	1 ,,	Seconds Kidney ..	,,	1	0	21,780	0	12	0	17½	12·45
	8 ,,	Flukes	,,	1	3	17,424	3	17	3	4	30·79
8	4 ,,	Flukes	,,	1	0	21,780	2	8	2	13	15·0
9	2 ,,	Flukes	,,	1	0	21,780	1	4	1	6	12·0
10	1 ,,	Flukes	,,	1	0	21,780	0	12	0	17½	12·10

:nthall, near Broseley, in 1865—rows all 2 feet apart—*continued.*

.	Number of Sets per Acre.	Weight of Sets per Acre.				Gross produce per Acre.				Net produce per Acre after deducting weight of Sets.				Produce per Set stated in ozs.	Increase of Crop in proportion to the weight of Sets.
		tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.		fold.
9	21,780	0	12	0	17¼	14	15	3	22½	14	3	3	5	24·35	24·35
0	29,040	0	16	0	23	7	14	1	27	6	18	1	4	9·53	9·53
1	43,560	1	4	1	6½	14	16	0	13	13	11	2	6½	12·18	12·18
2	21,780	1	4	1	6½	11	15	1	24	10	11	0	17½	19·30	9·65
3	29,040	1	12	1	18	14	1	3	35	12	9	2	7	17·40	8·70
4	43,560	2	8	2	13	8	6	2	13½	5	18	0	0½	6·85	3·42
5	21,780	2	8	2	13	13	8	2	11	12	16	1	22	22·10	5·52
6	29,040	3	4	3	8	17	18	3	9	14	14	0	1	22·14	5·53
7	17,424	1	18	3	16	10	19	2	27	9	0	3	11	22·60	5·66
8	21,780	4	17	0	26	11	19	0	3	7	1	3	5	19·66	2·45
9	21,780	3	12	3	19½	4	17	0	26	1	4	1	6½	8·00	1·33
0	21,780	0	12	0	17¼	12	9	2	18	11	17	2	1	20·54	20·54
1	21,780	1	4	1	6½	14	7	2	16½	13	3	1	10	23·66	11·83
2	21,780	2	8	2	13	13	3	1	24	10	15	3	11	22·50	5·62
3	21,780	3	12	3	19½	13	8	1	8	9	15	1	16	22·07	3·67
4	21,780	0	12	0	17¼	2	11	2	14	1	19	1	24	8·36	8·36
5	21,780	1	4	1	6½	3	17	3	4	2	13	1	25½	6·40	3·20
6	29,040	1	12	1	18	4	2	2	16½	2	10	0	26½	5·10	2·55
7	21,780	2	8	2	13	3	17	3	26	1	9	1	13	6·41	1·60
8	21,780	0	12	0	17¼	22	14	2	6¾	22	2	1	17½	37·40	37·40
9	29,040	0	16	0	23	19	0	3	8½	18	4	2	13½	23·50	23·50
0	43,560	1	4	1	6½	20	18	1	1	19	13	3	22½	17·20	17·20
1	21,780	1	4	1	6½	32	0	0	5	30	15	2	26½	52·66	26·33
2	29,040	1	12	1	18	35	2	0	26	33	9	3	8	43·33	21·66
3	43,560	2	8	2	13	34	16	1	19	32	7	3	6	28·65	14·32
4	21,780	2	8	2	13	27	17	3	13½	25	9	1	0½	45·90	11·47
5	29,040	3	4	3	8	21	12	2	20½	18	7	3	12½	26·70	6·67
6	17,424	1	18	3	16	18	6	2	7	16	7	2	19	37·70	9·42
7	21,780	4	17	0	26	38	19	2	25	34	2	1	27	64·15	8·01
8	21,780	3	12	3	19½	37	18	3	0	34	5	3	8	62·42	10·40
9	21,780	1	4	1	6½	24	11	2	7	23	7	1	0½	40·44	20·22

TATO CROP, made at Benthall, near Broseley, in 1864.

Gross Produce per Acre.				Net Produce per Acre after deducting Weight of Sets.				Rate of Increase.	Manure and Remarks. 20 Tons of Stable Manure used per Acre.
ns.	cwts.	qrs.	lbs.	tons.	cwts.	qrs.	lbs.		
17	2	1	21	12	5	1	23	3·52	Single rows, 2 feet apart.
14	2	0	14	11	13	2	1	5·80	Single rows, 2 feet apart.
10	6	1	6	9	2	0	0	8·53	Single rows, 2 feet apart.
9	6	3	14	6	18	1	1	3·48	Single rows, 2 feet apart.
7	17	2	22	6	13	1	16	6·77	Single rows, 2 feet apart.
7	11	1	8	6	19	0	18½	12·45	Single rows, 2 feet apart.
14	19	1	1	11	1	1	25	3·84	Single rows, 2 feet apart.
9	2	1	6½	6	13	2	21½	3·75	Single rows, 2 feet apart.
7	5	3	5	6	1	1	27	6·0	Single rows, 2 feet apart.
7	7	0	7	6	14	3	17½	12·10	Single rows, 2 feet apart.

close as to be prejudicial to the crop. The advantage, therefore, of large sets remains practically unimpaired.

Sixthly. Weight for weight cut sets produce, as nearly as possible, the same weight per acre as whole potatoes; but for the reasons given above, the weight of the sets should not be reduced by subdivision.

Seventhly. Smaller sets give a larger produce in proportion to their weight than the larger sets.

Eighthly. When the intervals between the sets in the rows are diminished to less than a foot, the produce of *each individual set* is proportionately diminished. Though this is not necessarily accompanied by a diminution of the weight of the crop, no increase in the produce of each individual set is caused by placing the sets at intervals wider than a foot.

Ninthly. With reference to the relative produce of different varieties, a *Late Red* sort takes the precedence throughout the experiments; and of the several varieties of Fluke, "Spencer's King of Flukes" and "The Queen of Flukes" are much more prolific than the ordinary variety.

XVII.—*On the improved value of Scotch Sheep.* By G. Murray.

The facilities now offered by railways and steamboats for the transport of Scotch sheep from their native grazings to southern farms—thus saving a journey which often lasted several weeks, to the injury of their health and condition—gives to the English farmer an increased interest in this kind of stock. The keen demand which has of late existed for sheep of all kinds, has also sent us further a-field in search of supplies: some notes, therefore, on the recent range of prices, and the efforts made to improve these mountain breeds, may be acceptable in an English journal.

The respective merits of the Black-faced Stock on the most exposed and barren grazings, unfit to winter young sheep; or, again, of the Cheviot on their range of conical hills, with here and there a sheltered dell, adjacent to rich cultivated lands, need not be enlarged upon, but the results of efforts to improve these native races are not so well known.

In the rainy climate of the far north the short and finer staple of the Cheviot wool is not so well suited to defend the skin of the animal from wet as the long, shaggy fleece of the Black-face, besides the Cheviots are more liable to be attacked with rot than the Black-faces, even when both are grazed on the same grazings, in consequence of their preferring the low boggy parts for the sake of shelter, whilst the Black-faces invariably prefer the dry bare heights for their beds; yet even here the use

of a Cheviot ram with Black-faced ewes has been successful, giving an extra value of 5*s.* to the lamb.*

In all the Border counties, on the medium high ranges, where the climate is not too bleak and severe, and some portion of turnips can be got in winter, the Leicester-Cheviot cross has answered admirably. The increased value of the lamb at weaning time has of late been about 15*s.* per head over the pure-bred Cheviot. The tegs cut one-third more wool, the extra quality of which has enhanced the value by 2½*d.* per lb. The quality of the mutton is excellent; they are kind feeders and attain good weights at an early age; if kept equally well from the first they would probably prove a better paying sheep than the more tender Leicester of the South. The only drawback is the difficulty of maintaining a stock of ewes, as it does not answer to go beyond the first cross.

The change effected within the last twenty years in the climate of Scotland by the improvement of the low boggy lands, and by well-directed surface drainage, is conducive to the introduction of such an improved breed of sheep.

In the autumn of 1865 the high price of sheep in the midland counties induced me to travel to the North at the time of the border fairs to look out for purchases, as well as to be present at the annual sheep sale of a crack breeder in Northumberland.

Arriving at Berwick, after a journey of 300 miles, I went next morning to the market, where a lot of good Cheviot wethers attracted my attention, and I was at some pains to make out their price; they were bought by a dealer for the Newcastle Market at 63*s.* per head. Proceeding thence to Kelso sheep-fair I found draft ewes, half-breds, ranging from 51*s.* to 56*s.* per head. I next attended Messrs. Borthwick's annual sale by auction at Kilhain, in Northumberland, where 1000 half-bred shearlings wethers made from 59*s.* to 77*s.* per head; 1000 ewes and theaves making from 40*s.* to 57*s.* Next day, at the greater border fair of St. Ninians, half-bred Leicester and Cheviot ewes made 46*s.* to 54*s.*, and three parts bred 48*s.* to 56*s.* At the ewe fair held at Oldhamstocks on the following day, three-parts-bred ewes made from 53*s.* 6*d.* to 66*s.* and half-bred Leicester and Cheviot from 53*s.* 9*d.* to 69*s.* The Thurston Mains half-breds, being very superior, made, from 55*s.* to 70*s.*, while the Southdowns from the same farm were sold at from 51*s.* to 59*s.* 6*d.*, and several other lots of Southdowns fetched from 47*s.* 6*d.* to 54*s.* I need hardly say that I returned to the south without having purchased a single sheep.

High as were these prices in 1865, those of 1866 ranged still higher, though the pretensions of the breeders were by no means

* I am indebted to Mr. Lauder for information on this subject.

satisfied. Of the Inverness July fair, now the most important in Scotland, we were then told that business was very slack, many farmers leaving the market without having sold a single animal; yet for Cheviot wethers an advance of 6*s.* to 8*s.* per head over the prices of the previous year was asked; ewes and ewe lambs made 8*s.* or 10*s.* more, and wether lambs 3*s.* to 5*s.* above the prices of 1865, this, too, in spite of a fall of 20 per cent. in the value of wool. The price of Cheviot wethers was from 30*s.* to 50*s.*, Cheviot ewes 33*s.* to 42*s.*, wether lambs 18*s.* to 23*s.*, ewe lambs 17*s.* to 24*s.*: Black-faced wethers made from 27*s.* to 40*s.*, ewes from 27*s.* to 36*s.*, lambs from 16*s.* to 22*s.*, half-bred hogs made from 42*s.* to 50*s.*, and lambs from 25*s.* to 32*s.*

At the July fair of 1867 prices had greatly receded. Cheviot wethers were from 10*s.* to 12*s.* per head lower. Ewes from 12*s.* to 14*s.*, lambs from 6*s.* to 7*s.*, half-bred lambs from 4*s.* to 6*s.* The stockmasters, however, are on the whole well satisfied, the general feeling amongst them being that prices will not be lower for Cheviot sheep.

I have before me a list of the prices at this Inverness fair from its commencement in 1818, down to the present date. I will only make a selection from this long column of figures, adding a few remarks on the different periods.

From 1818 to 1830 prices fluctuated much, but the average was low. For instance the prices of 1825 were nearly double of those of 1822 and 1823.

From 1830 to 1850 prices were remarkably steady, with an upward tendency, but in 1853, and again in 1860, trade received a new impulse, which attained its height in 1866. The following selection from this table will illustrate the course of events pointing out some of the years of highest and lowest prices:—

PRICES OF CHEVIOT SHEEP AT INVERNESS FAIR.

Year.	Wedders.	Ewes.	Lambs.	Remarks.
	s. *d.* *s.* *d.*	*s.* *d.* *s.* *d.*	*s.* *d.* *s.* *d.*	
1820	20 0 to 25 0	16 0 to 17 0	10 0 to 11 0	
1822	12 6 „ 13 0	8 0 „ 8 6	4 6 „ 6 0	low year
1825	29 0 „ 32 0	15 0 „ 19 0	9 0 „ 10 6	high
1830	15 0 „ 21 0	8 0 „ 11 0	6 0 „ 6 9	
1833	22 0 „ 31 0	13 6 „ 21 0	9 0 „ 11 6	average
1840	24 0 „ 33 0	15 0 „ 23 0	7 0 „ 11 6	good average
1843	19 0 „ 25 0	8 0 „ 12 0	5 0 „ 8 0	low
1845	23 0 „ 33 0	13 0 „ 20 0	8 0 „ 13 0	
1850	20 6 „ 29 6	12 0 „ 20 0	8 0 „ 13 0	
1853	26 6 „ 38 0	17 0 „ 28 6	9 0 „ 17 0	
1858	24 0 „ 34 6	16 0 „ 25 0	13 3 „ 14 9	low
1860	26 0 „ 38 0	17 6 „ 27 6	12 6 „ 17 6	
1864	31 0 „ 41 0	21 0 „ 31 6	14 0 „ 18 0	
1865	32 6 „ 44 0	22 6 „ 33 6	14 6 „ 20 0	
1866	30 0 „ 50 0	27 0 „ 36 0	16 0 „ 22 0	
1867	29 0 „ 37 0	20 0 „ 28 0	13 0 „ 20 0	

As a further illustration of the range of prices within the last two years, I may mention that at Melrose, which has the reputation of having the largest lamb-fair in the south of Scotland, on the 14th of August, 1866, from 70,000 to 80,000 lambs were shown, being fully 10,000 above the number of the previous year. The quality was also good; but prices had considerably receded—half-bred lambs were down from 5*s.* to 6*s.* At the same fair in August, 1867, there were 80,000 lambs on offer, scarcely equal in condition to those of last year. Prices were still further reduced, so that the best lots made from 10*s.* to 12*s.* less than last year, the highest price obtained for three-parts-bred lambs was 27*s.* per head.

At Lockerby, in 1866, upwards of 30,000 lambs were shown, chiefly from Dumfriesshire; half-bred lambs made from 28*s.* to 43*s.*; Cheviots, from 18*s.* to 29*s.* At this same fair in 1867, the numbers shown were estimated at 70,000; prices for every description had fallen from 30 to 50, and, in some instances, even 60 per cent. below those of last year. Half-bred lambs made from 20*s.* to 25*s.* 6*d.*; Cheviot wedder lambs from 6*s.* 6*d.* to 10*s.* 6*d.*; Cheviot ewe lambs from 10*s.* to 12*s.* In several instances wedder lambs were sold at 7*s.*, the price they obtained from the same farms last year being 18*s.* to 19*s.* Last year a lot of Cheviot ewe lambs made 25*s.* 9*d.*; this year, from the same farm, they only realised 11*s.*

The Earl of Durham's annual sale of fat stock was held at Fence Houses, on the 20th November, 1866, where 800 fat sheep were sold. The average prices were as follows:—

		s.	*d.*
60	Half-bred Leicester and Cheviot Wethers averaged	76	4
100	" " Theaves "	63	0
20	Southdown Wethers averaged	79	0
40	" Theaves "	68	3
30	" Wethers "	80	2
36	" Theaves "	62	0¼
210	Half-bred Leicester and Cheviot Ewes averaged	64	4¼
304	Cheviot Ewes averaged	52	8¾

It afforded a good illustration of the comparative value of the Leicester, Cheviot, and the Southdown; and I consider that, if equal numbers of each breed had been on sale, the crosses would have made more money per head than their aristocratic rivals. If it be objected that this trial was not a fair one, the soil and climate being unfavourable to the Southdown, my answer is that 20 Southdowns, worth over 4*l.* each, could not but possess merits of no mean order, and be fair specimens of the race.

At the Dumfries Show, held on the 13th December last, for the best pen of 5 half-bred shearling wethers, under 22 months, the first prize was awarded to Mr. R. Smith, Ladyland; these

sheep were sold the same day to Mr. P. Murphy, butcher, at 5*l.* 8*s.* per head. The heaviest weighed 315 lbs. live weight, and the average was 278 lbs.

The second prize pen of 5, belonging to Mr. P. M. Johnstone, Bankhead, Dalswinton, averaged 235 lbs.; they were sold at 5*l.* 2*s.* 6d. each.

The first prize—a cross between the Blackfaced ewe and the Leicester ram—was awarded to Mr. R. Webster, Arras Kells; these sheep, under 22 months old, were sold at 4*l.* 1*s.* 6*d.* each.

In the class for sheep of any breed, the first prize was awarded to a pen of pure-bred Leicesters, shown by Mr. P. M. Johnstone; the heaviest weighed 276 lbs. live weight, and averaged 262 lbs., and realised 5*l.* 7*s.* 6*d.* each. The second prize was awarded to a pen of sheep, 2 years old, a cross between the Black-faced ewe and Leicester ram; the heaviest weighed 276 lbs. live weight, and the five averaged 268 lbs., and were sold at 5*l.* 12*s.* per head.

In the class for pure-bred Cheviots, under 22 months old, the first prize was awarded to Mr. M'Gill, Rotchell; the average weight of this pen was 209 lbs. live weight; they fetched 4*l.* 9*s.* each. The second prize lot in the same class made 4*l.* each. A pen of half-breds, Leicester and Cheviot, one year old, averaged 273 lbs.; this lot was also shown by Mr. M'Gill. The first prize Black-faced wethers made 3*l.* 7*s.* 6*d.* each.

That this improvement in value has not been effected without pains and expense, on the part of breeders, is evidenced by the prices paid for rams obtained from flocks of high reputation; for instance, on the 13th September, 1865, 169 Cheviot rams sold by public auction at Beattock, by Mr. Oliver of Hawick, made the following prices:—

	£	*s.*	*d.*
1 Five Shear Ram	38	0	0
18 Four Shears averaged	26	6	1
The highest price being	115	0	0
60 Three year-olds averaged	15	11	3
The highest price of this lot being	155	0	0
64 Two year-olds averaged	14	18	8
Highest price	121	0	0
26 Yearlings averaged	6	13	5
The highest price was	18	0	0

The 169 sheep realised in the aggregate the high sum of 2484*l.* 10*s.*, or an average of 14*l.* 14*s.* per head, which is the best proof we can give of the high estimation in which this breed is held by the flockmasters of the Border counties.

During the year 1864, the gross number of fat sheep sent south by rail from Dumfries alone was 40,000, the greater part of which were cross-breds, worth from 45*s.* to 65*s.* per head. A large

farmer, well acquainted with the south-western counties of Scotland, wrote to me as follows:—"I know many farms in Scotland, from which a few years ago the Black-faced lambs averaged 10*s.* per head, that are now selling—the produce of the same ewe by a Leicester ram—at 24*s.* The Leicester ram is by far the best cross for the Black-faced ewes, at least in this part of the country. The cross betwixt the Cheviot and Leicester answers admirably on all the best farms, while on the poorer farms we greatly prefer the Black-faced cross. A farmer near Kirkcudbright, last spring, sold his first draft of tegs in May, out of the wool, at 60*s.* per head, the fleeces averaging 9¼ lbs.; of course they were a cross between the Leicester and Cheviot; this may be considered an extreme case, yet there are hundreds to be found in the same locality weighing in spring 18 lbs. to 20 lbs. per quarter, and cutting 8 lbs. of wool each.

At the great ram fair held at Hawick, 372 Leicester rams were sold by public auction, the average of which was 5*l.* 17*s.* 7*d.* per head, the highest price being 14*l.* 10*s.*

At the Lockerby Show, held in April, 1865, the first prize hogs weighed 180 lbs. live weight, which was the highest average ever known at this Show.

Within the last ten years the number of crosses with the different mountain breeds have increased at least threefold; the only limits to the system of crossing will be the deficiency in the supply of the pure element in the female line. Since, however, there are large areas which can never be stocked by any but the pure native races, we may reckon on these moors and mountains to furnish to more favoured localities their surplus produce. It is a remarkable fact, well known to practical men, that in breeding from a Black-faced ewe by a Leicester ram the produce decreases in value with each successive family; hence, when ewes have twice bred to a Leicester sheep, they are known by the name of double-milled ewes, and, though still young, are rejected by the experienced breeders as deteriorated in value.

I have thus endeavoured to put together a few remarks, the result of many inquiries, which I trust may be of use in calling attention to a valuable source of supply for store sheep, and also serve to illustrate the remarkable rise and fall in the value of sheep, which has taken place within the last two years.

XVIII.—*Statistics of Live Stock and Dead Meat for Consumption in the Metropolis.* By Robert Herbert.

In the first six months of the present year, notwithstanding a deficiency in the importations of foreign stock, compared with the corresponding period in 1866, the great metropolitan cattle-market was fairly, though not to say heavily, supplied with beasts in greatly improved condition as far as regards English arrivals. The Scotch supplies were remarkably prime; but the few Irish beasts brought forward were scarcely of average weight. On the whole, the trade ruled steady, and prices were supported. The general value of Scots and crosses ranged from 5*s.* to 5*s.* 4*d.* per 8 lbs. The Norfolk "season" closed remarkably well; whilst Lincolnshire, Leicestershire, and Northamptonshire are now forwarding some very good stock, and in full average number. In 1866, the best Scots were at one time worth as much as 6*s.* 4*d.* per 8 lbs., the fall being equal to 1½*d.* per lb. This decline, however, may be attributed to the restrictive measures still in force in reference to the removal of beasts from London for consumption in the country. Formerly from 500 to 600 prime beasts were frequently thus disposed of. Whilst the imports of live stock from the continent have fallen off, we have had very large quantities of foreign, chiefly Dutch, meat on offer in Newgate and Leadenhall, from which markets country buyers have been partly supplied. The supply of meat actually imported in the period under review was very little short of 150,000 tons. A large portion of it has arrived in fair saleable condition; but the prices realised have been comparatively low. We understand that the importations during the winter months will be on a very extensive scale, as there is a growing demand for offal in most of the continental cities. The same may be said of Scotland and most of our own districts, in which wool and skins are selling at higher prices than in the metropolis. As we are now gradually recovering from the effects of the cattle disease, and as stock is still very abundant in Holland and Germany, we may safely anticipate a moderate range in the value of animal food for several months. Some very good beasts have been received from France, but that country has very little to spare for us compared with Holland, Belgium, and Germany. The exertions made to improve the breed of sheep in Holland and Germany by means of crossing have been attended with considerable success; still much has yet to be done to secure high prices in this country.

The total number of sheep brought forward has not been quite equal to that of last year, but the condition of most English

breeds has shown considerable improvement; hence the *weight* of meat disposed of has exceeded 1866. This, together with the ample supplies exhibited and disposed of in Newgate and Leadenhall, accounts for the moderate prices current during the last six months. The average top quotation for mutton has not exceeded 5*s.* per 8 lbs. against 6*s.* in the corresponding period in 1866, and 5*s.* 10*d.* in 1865.

Of lambs there has been a full average. Sales, therefore, have been rather inactive; at one period, the best Down lambs sold at 9*s.* per 8 lbs.; but the price soon fell to 8*s.*, and at the close of June was at 6*s.* 8*d.* per 8 lbs. In 1866 prices ranged from 6*s.* 8*d.* to 10*s.* per 8 lbs.

Although the importations of foreign calves have been only moderate, the veal trade has not improved. The best calves have realised over 6*s.* per 8 lbs.; but, as the number of English has been on the increase, there has been rather more competition in the market.

The supplies of pigs having been extensive, both English and foreign breeds have sold slowly, at prices ranging from 3*s.* 6*d.* to 4*s.* 6*d.* per 8 lbs.

Grass-fed stock has thriven well, and we believe that it was never in a more healthy state than at present. A very large crop of hay has been secured, and the prospect of root crops is fully equal that of last season. The outlay for artificial food, therefore, will certainly not increase.

The following return shows the total supplies of stock exhibited in the Metropolitan Cattle Market in the six months:—

Total Supplies of Stock exhibited.

	Beasts.	Cows.	Sheep and Lambs.	Calves.	Pigs.
1861	109,812	3005	604,650	6,560	15,952
1862	116,735	3054	631,672	8,259	17,407
1863	120,045	3005	628,072	10,449	16,435
1864	131,694	3014	622,330	9,935	17,679
1865	130,977	3086	614,766	12,189	16,028
1866	107,816	1220	677,560	6,721	12,953
1867	108,180	1400	674,670	8,468	11,200

The supply from our northern districts was small—from the eastern counties on the increase. Other parts of England fur-

nished good supplies; but from Ireland and Scotland the receipts were limited, as will be seen from the annexed figures:—

District Bullock Arrivals.

	Northern Districts.	Eastern Districts.	Other parts of England.	Scotland.	Ireland.
1860	4,000	68,520	21,420	5,033	1477
1864	..	62,170	19,980	9,918	2740
1865	1,000	54,460	17,570	11,797	2517
1866	5,290	31,188	12,680	8,800	3000
1867	400	36,630	14,110	5,632	903

Average Prices of Beef and Mutton in the Six Months.

Beef.—Per 8 lbs. to sink the Offal.

	1861.	1862.	1863.	1864.	1865.	1866.	1867.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Inferior ..	3 4	3 0	3 4	3 6	3 8	3 10	3 4
Middling ..	4 4	4 0	4 4	4 6	4 8	4 10	4 4
Prime ..	5 0	4 8	5 0	5 0	5 2	5 10	5 0

Mutton.—Per 8 lbs. to sink the Offal.

	1861.	1862.	1863.	1864.	1865.	1866.	1867.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Inferior ..	3 8	3 6	3 10	3 8	4 4	4 0	3 6
Middling ..	5 0	4 6	4 8	4 6	4 10	5 4	4 6
Prime ..	5 10	5 4	5 6	5 2	5 10	6 0	5 0

Although trade in the manufacturing districts has been somewhat heavy this year, the consumption of animal food in the United Kingdom is fully as large as at any former period. Prices, however, as we have shown above, are now considerably lower than they were in 1866. But the fact appears to be that the rates current in that year were too high to be lasting.

The total imports of foreign stock into London during the six months were as under:—

Imports in the first Six Months.

From	Beasts.	Sheep and Lambs.	Calves.	Pigs.
Aalborg..	231	16	..	..
Amsterdam	..	1	..	..
Antwerp	2,471	86,736	3,798	158
Barcelona	50	..	..	..
Boulogne	3,905	3,316	345	5
Bremen	3,640	5,498	145	..
Cadiz	717	..	..	..
Caen	79	..	14	..
Calais	..	694	235	41
Copenhagen	345	..	..	..
Deauville	89	..	..	..
Dieppe	118	..	..	..
Dunkirk	54	..	..	..
Gerstemunde	15,545	35,904	343	55
Gothenburg	2,779	710	146	5
Hamburg	8,610	46,217	565	122
Harburg	380	..	..	..
Harlingen	4,777	8,844	1,030	179
Jersey	2	..	..	..
Königsberg	44	..	..	..
Oporto	579	..	..	..
Ostend	2	920	1,601	37
Randers..	944	3	2	10
Rotterdam	..	138	53	4,332
Standby	215	..	..	..
Tromville	418	..	..	..
Total	45,994	188,997	8,277	4,944

The above gives a total of 248,212 head, against 244,985 head in the same period in 1866:—

Imports at Corresponding Periods.

	Beasts.	Sheep and Lambs.	Calves.	Pigs.
1860	17,193	76,415	7,965	2,492
1861	22,045	46,674	6,187	4,309
1862	11,462	49,332	9,459	883
1863	16,701	91,206	11,445	1,229
1864	29,460	85,920	10,392	14,212
1865	40,921	122,579	9,993	32,582
1866	46,343	180,460	7,480	10,702

The returns issued by the Board of Trade give the following imports of foreign stock into the United Kingdom in six months:—

Imports in Six Months.

	1865.	1866.	1867.
Oxen, Bulls, and Cows	74,392	72,812	69,110
Calves	18,785	9,122	11,558
Sheep and Lambs	250,212	411,729	268,478
Pigs	38,706	29,873	13,776

The supplies of meat in Newgate and Leadenhall have been extensive, business steady, and prices moderate. Beef has ranged from 3*s.* 2*d.* to 4*s.* 10*d.*; mutton, 3*s.* 4*d.* to 5*s.*; lamb, 4*s.* 4*d.* to 7*s.*; veal, 3*s.* 10*d.* to 5*s.* 2*d.*; and pork, 3*s.* 2*d.* to 5*s.* per 8 lbs. by the carcase.

The Wool Trade.

A further decline has taken place in the value of all kinds of wool. At the large public sales of colonial held in London the quotations gave way ½*d.* to 1½*d.* per lb.; and in the private contract market a similar decline has taken place. The fact is, that production has overtaken the wants of Europe, and that, without a good export inquiry for France, Belgium, and Germany, even present rates are not safe. The quantity of colonial wool advertised for sale in August and September was 119,399 bales, to which about 30,000 bales were added, bringing the total quantity up to about 150,000 bales. The oppressively high duties levied in America on wool and woollen goods have, no doubt, partly tended to depress the value of wool in this country. Our impression is, however, that the consumption of British manufactured cloth in the United States will steadily increase. The last clip of English wool was large and of full average quality. The following are the present values of English wool in London:—

	Per 240 lbs. £.	s.		£.	s.
Fleeces:—					
Southdown hoggetts	16	10	to	17	0
Half-bred hoggetts	17	10	to	18	0
Kent fleeces	17	0	to	17	10
Southdown ewes and wethers	15	0	to	16	0
Leicester ditto	16	0	to	17	0
Sorts:—					
Clothing and picklock	18	0	to	18	10
Prime	16	10	to	17	0
Choice	15	10	to	16	0
Super	14	0	to	15	0
Combing:—					
Wether matching	19	0	to	19	10
Picklock	16	0	to	17	0
Common	14	0	to	15	0
Hop matching	20	0	to	20	10
Picklock matching	16	0	to	17	0
Super ditto	14	0	to	15	0

Compared with the same period in 1866, the above quotations show a decline of from 10*s.* to 30*s.* per pack.

Imports of Wool in Six Months.

	1865.	1866.	1867.
	lbs.	lbs.	lbs.
Colonial .. .. .. / Foreign	87,470,008	101,948,949	117,220,028

Exports of Wool in Six Months.

	1865.	1866.	1867.
	lbs.	lbs.	lbs.
English	4,014,604	3,566,886	3,117,235
Colonial	36,526,133	29,451,959	39,626,742
Foreign	5,304,109	2,540,984	6,035,779
Total	45,844,846	35,559,829	48,779,756

4, *Argyle Square, St. Pancras.*

XIX.—*On the Composition and Nutritive Value of Anthyllis Vulneraria* (*Lady's Fingers*) *as a Fodder Plant.* By Dr. Augustus Voelcker.

The Anthyllis Vulneraria (Lady's Fingers, or Kidney Vetch), grows wild throughout the length and breadth of England. It is very common on dry pastures and rocky or stony places; but though it may be seen on a great variety of soils, and is apparently independent of the prevailing mineral constituents of the land on which it grows, it is naturally a lover of the limestone, and flourishes on the thin oolitic soils of the Coltswold hills, and generally on calcareous and open sandy land.

Of late years the Anthyllis has been recommended for cultivation as a fodder plant; it is reported to yield a large crop of hay and green food, which is specially useful for sheep, and to succeed well on soils too poor for the growth of broad clover. It certainly grows on extremely poor pastures and dry sheep-walks, and is apparently relished by sheep; but whether it is, as has been asserted, an extremely nutritious food, even when grown on the poorest soils, we have no evidence to show.

Probably it may be grown to the best advantage on calcareous sandy soils, and there yield better or more abundant fodder than

they would produce in the shape of sainfoin or clover to which tribe of plants it is akin.

The cultivation of this crop has been attempted with some degree of success in Norfolk, the county from which I obtained the material for the subjoined analysis. More frequently than in England the Anthyllis may be seen as a field-crop in France, where it is grown much in the same way as the *Trifolium incarnatum*, that is, well harrowed after harvest into the oat or wheat-stubbles, it is then ready for feeding the following summer, coming in rather later as a green crop than the crimson clover (*Trifolium incarnatum*).

I am not aware that this plant has been submitted before to an analytical examination; so, having received from Norfolk some hay entirely composed of the kidney vetch, I took advantage of the opportunity, and subjected it to a full analysis.

The hay in question, as regards appearance, was stalky and coarse; it must not be supposed, however, that the crop was mown too late in the season, for most of the plants had just done flowering, and some were still in full flower.

The plan adopted in the following analysis was similar to that described at some length in my paper "On the Composition of Orange Globe Mangolds" in Vol. II., Second Series, of this Journal, I need not, therefore, mention in detail the mode in which the several determinations were made, but give at once the general composition of the hay, as follows;

		Dried at 212° Fahr
Moisture	10·46	..
*Organic substances soluble in water	26·47	29·56
Organic substances insoluble in water (crude fibre)	57·99	64·76
Mineral matter (ash)	5·08	5·68
	100·00	100·00
*Containing nitrogen	1·19	1·33
Equal to albuminous compounds (flesh-forming matters)	7·39	8·25

Hay usually contains from 14 to 16 per cent. of moisture, or 4 to 6 per cent. more than the Anthyllis hay at the time when the analysis was made. The day on which I received the hay was very warm; the small sample coming into my hand probably was drier than the bulk is likely to be at the time of stacking; in some measure, however, I believe that the small amount of moisture was due to the deficiency of small leaves (which attract moisture readily), the want of juice, and the prevalence of dry woody stems in the Anthyllis hay.

The following figures express the

Detailed Composition of Hay, made of the Anthyllis Vulneraria (Kidney Vetch).

		Calculated quite Dry.
Moisture	10·46	..
Oil and wax	1·18	1·32
*Soluble albuminous compounds	2·87	3·20
†Insoluble albuminous compounds	4·52	5·04
Gum, sugar, and carbon-hydrates, readily convertible into sugar	43·91	49·04
Indigestible woody fibre (cellulose)	31·98	35·72
Mineral matters, soluble in water	4·50	5·03
Mineral matter, insoluble in water	·58	·65
	100·00	100·00
*Containing nitrogen	·47	·52
†Containing nitrogen	·72	·80

The sample of hay analysed by me was not nearly so nutritious as clover, sainfoin, or common meadow-hay of good average quality.

A comparison of the relative proportions of fatty matters, of sugar and analogous carbon-hydrates readily soluble in water, of albuminous compounds and of indigestible woody fibre in different kinds of hay, enables us to form a good proximate estimate of their nutritive qualities. The comparison should always be made in the perfectly dry materials, for the proportion of water in hay is subject to great variations.

The inferiority of the Anthyllis hay appears in a marked degree in the following tabular statement ;—

Composition of Clover-hay, Meadow-hay, and of Anthyllis-hay, dried at 212° Fahr.

	Clover-hay.	Meadow-hay.	Anthyllis-hay.
Fatty matters	3·81	2·99	1·32
*Albuminous compounds (flesh-forming matters)	18·96	9·88	8·25
Sugar, gum, and carbon-hydrates, readily convertible into sugar (respiratory substances)	41·27	48·09	49·03
Indigestible woody fibre (cellulose)	26·95	31·80	35·72
Mineral matter (ash)	9·01	7·24	5·68
	100·00	100·00	100·00
*Containing nitrogen	3·03	1·58	1·32

A glance at the preceding table shows—

1. That the Kidney-Vetch-hay examined by me contained only one-third the amount of ready-made fat which occurs in good clover-hay, and scarcely half the amount found in ordinary meadow-hay.

2. That it was somewhat poorer in albuminous compounds or flesh-forming matters than common meadow-hay, and contained nothing like the amount of these compounds which occurs in clover-hay.

I was rather surprised to find so little flesh-forming matter in the Anthyllis, for the plant belongs to the natural order of Leguminosæ, a tribe which is distinguished by a much larger amount of nitrogenous compounds than is found in true grasses. The hay analysed by me, however, as mentioned already, was decidedly stalky, and the comparative paucity of tender leaves, which are always rich in nitrogen, and the prevalence of woody fibre (cellulose), a substance not containing any nitrogen, no doubt accounts for the deficiency of flesh-forming matter, which, comparatively speaking, may not be so great when the crop is eaten green, as it is when made into hay.

3. That the Anthyllis contains more indigestible woody fibre than either meadow- or clover-hay.

The small percentage of ready-made fat and of flesh-forming matters, and the large amount of woody fibre in the sample, certainly do not speak in favour of Anthyllis as a forage plant. It must, however, be remembered that my remarks, strictly speaking, only apply to the specimens analysed by me, and that we have yet to learn what is the average composition of the crop before a generally correct opinion can be expressed as regards the nutritive value of *Anthyllis Vulneraria.* This plant, at least when grown on poor sandy soils, has a great tendency to drop, towards its maturity, the finer and more nutritious leaves, and to become stalky and coarse. It may, therefore, be better on such soils to consume it green than to make it into hay. In a given state I am inclined to think the plant would compare more favourably with green clover than hay made from the Kidney Vetch will with clover-hay.

Laboratory, 11, *Salisbury Square*, *Fleet Street*,
July, 1867.

XX.—*Remarks on the Implement Department at Bury.* By EARL CATHCART, Senior Steward.

NIMROD used to say, I can part with the horse, but not with his condition. So the Society—the thing being divisible—should part with its stewards, not with their experience. Mr. Wren Hoskyn, Sir A. Macdonald, and Mr. Caldwell, have written valuable papers on previous meetings: would that their example

had been regularly followed. A fresh eye is of essential importance towards a duly progressive system. It is now my object to record the experiences of three busy years of office; to preserve the mere residuum—the moral "Extractum Carnis."

Many things pass as a whole that would never pass in part. I am proud of having been an officer of the Society; and yield to no man in appreciation of its importance, past, present, and to come. Those who studied the Bury Meeting may well be satisfied with general results; yet in speaking of details in my own department I must be critical—if not critical, I am nothing. Whatever may be thought of my opinion, credit I know will be given to my motives, and my observations will not be less relished because they are outspoken. I am to deal chiefly with principles, because for the third time consecutively the Society is to have the advantage of Mr. Coleman's practical notes on the general show-yard. Before entering in order upon our subject, let me stay to pitch one or two preliminary key-notes. There is an activity positively contagious—a keen interest—insight—a tendency to encourage, not to snub, a suggestion—a hatred of measureless content—these qualities are required to counteract the natural drowsiness of institutions. Those who this year studied two great agricultural meetings were struck by some reflection such as this:—If management requires breadth and unity, may we not unduly sacrifice unity for breadth?

It would be pleasant to dwell on picturesque and hospitable Bury; to refer to Suffolk, the home of that farmer-penman, Arthur Young; and birthplace of the poet of the farm, of whom it was well said—

"Bloomfield, thy happy omen'd name
Ensures continuance to thy fame;
Both sense and truth this verdict give—
While fields shall bloom thy name shall live."

Space does not allow even for the great event of the Meeting—the visit of the Viceroy of Egypt—more than a passing notice. Despite the fickle weather, here at least, his Highness was thoroughly satisfied with his reception. With an evident knowledge of agriculture and mechanics, he was full of sympathy with our object, and left a most agreeable impression. He told us at luncheon how he had himself adapted his steam-plough tackle to work earth-levelling shovels, and he applied two bills of fare to illustrate the process. The great ruler in Egypt must have been impressed by the forty-two acres covered with everything that could exemplify the perfection of modern agriculture: still more must he have been impressed if he reflected that he saw an outward and visible sign of that hidden force destined to expand, to fill, and to move the wide world, and

which may be indicated by two plain words—freedom and co-operation. His Highness was evidently "not one to travel from Dan to Beersheba, and cry—'tis all barren."

The principal characteristics of the last exhibition of Implements are briefly these:—On account of the exclusion of cattle, the Bury Show was essentially an implement show; considering the value of the implements, perhaps the best exhibition ever known: remarkable more because of perfectionment of parts than for novelty of design; and for evidence of the steady advance of steam power as applied to agriculture. With steam tackle, heat being power, to cherish heat is the great object; hence the goal for racer engines, and, in the best sense of the word, engine jockeys. Traction engines—called in the yard tractarians, were a noteworthy feature, and snorted about in all directions; there was no prize for these mechanical Calibans: yet probably for them there is a great future. Might not a curious paper be written on the history of implements; how they became naturalized in agriculture? Large entries and extensive trials, with corresponding pressure on stewards and judges, pointed to the absolute necessity of avoiding any tendency in the implement department to become hide-bound. A characteristic and perhaps valuable feature is to be found in the fact that there is a minnimum of official interference. In short, the Society opens the door—personal interest walks in and about. The general meeting in the yard being merely a form, a characteristic of our agricultural convocation is now, all work, no talk. The Sunday service in the yard is interesting and appreciated. When at Bury the clergyman said, "I beg you to accept the prayer-books you have used," the general response, "Thank you kindly, sir," was touching. The visitors of the labouring class were intelligent; none trudged unknowing and whistled for want of thought. An important teaching of the implement yard is, that improved agriculture must have improved servants; and this leads me to refer to two important considerations—the promotion of education, and the encouragement of rational cheerfulness—for

"A merry heart goes all the day,
Your sad tires in a mile-a."

The key to the future of the implement department is in the phrase, "the spirit of the time must teach us speed." Consider the growth and the tendencies of our population, study American analogies, and we see that our necessities will lead every day to the increased use of machinery in agriculture—necessity being the motive, competition the machinery of progress. It is to be observed that, as regards any Government, reforms are apt to come from without; at least a system should be viewed from

without. I advocate no dog-and-the-shadow principles. You can't run far before your day; time itself, that changes all things, changes by degrees. To preserve things we must go back to our original principles: acting less from habit, more from reflection. Improvement in the yard like improvement in the implements, must be made step by step—improvement of details resulting from a close application of that science of sciences—applied common sense; its disturbing influences are possibly laxity, and rhinoceros-skinned routine. As we hear less in these days of judges and more of juries, where for the purpose of exhibitions does the essential difference lie? Prejudices of the pocket are not likely to interfere with the wished-for progress in the future: all we want is concentrated, sympathetic, receptive management. As regards the agricultural mind, insight; as regards the agricultural voice, fine perception. The agricultural and engineering press is able. "By evil report and good report," when construed together, much may be learned. That press is a sort of tree of knowledge—the pulse of the agricultural body—and on that pulse we should ever have a sensitive finger. The difficulties of the future implement department are great, like the steam-hammer, which can smash a boulder or crack a nut, we must so justly arrange our testing machinery that we do even-handed justice alike to the Triton manufacturer and the minnow embryo.

Reader, do you know the good old play 'Speed the Plough?' and the oft-repeated and now proverbial question "What will Mrs. Grundy say?" Even Mrs. Grundy would, I am sure, have approved the following preface to a few practical suggestions:—Little things are little things till neglected; how many things are out of mind when out of view? In our yard there might be at either end of every row of sheds a notice to show the number of the stands comprised in that row; a sort of thing that those who run may read. There are two nuisances that should be sternly repressed—a sort of "cheap John's" noisy vendor of small wares, and the wet-paint nuisance. There is too much black smoke in the implement yard; this is the result of bad fuel and bad stoking. Care should be taken to avoid an issue of incorrect prize-lists. The undecorated "tractarians" should be controlled in their gyrations, but not unduly trammelled. The police of the implement yard requires consideration; fires to be duly raked out by a certain hour. In reference to the Suffolk Societies' Prize, would it not be desirable to obtain a Report on the Plans and Models of Labourers' Cottages? Might not the very efficient, Assistant-Steward of implements be more employed? There was a want of shelter for the implement trials; there has been sad loss of all-important time

in measuring and setting out portions of land for trials. The implement trial-floors were injudiciously constructed, and provoking difficulties in connecting centres on line of motion. No crane, and so no end of dragging and shunting heavy mills. The crying want with us is more forethought and combined action as regards field and yard trials.*

The importance of "the soft answer," is nowhere better exemplified that in the office of Implement Steward. If my last year of office could return, I would say to my colleagues, "There is ample work for three of us; we will each take our department: I would not fear your discretion, only each day *report*, so that we are not at cross-purposes. We must, as far as may be, keep up the tone in our yard. The Society is bound to carry out its conditions; routine must give way to utility; we are not Medes and Persians. And above all it is essential that the governors should sympathise with the governed." Whilst referring to the office of Steward, it is due that I should record my sense of the good service rendered by the Assistant-Steward, Mr. Elphick.

The prize system hinges on the due selection of judges; and the secret of being able to obtain judges depends on the fact "that the labour we delight in physics pain." That we may not overstrain this tendency to labour for love, let us consider the duties, qualifications, and treatment of our implement judges. Nothing is more sensitive than credit, and the judge's decision immediately affects credit. The number of judges is limited; there is often undue hurry; sometimes a five minutes' run where an hour is required. In short, judges are often unduly worked, and unduly blamed. A judge should be a man of experience, of a fine temper; he should not only avoid haste, but the appearance of haste. As Lord Bacon says, patience and gravity of bearing is an essential part of justice. The general public know little of the laborious and intricate trials. Forethought and further division of labour is the solution of many of our difficulties. We must at once subdivide the Miscellaneous Department, which, indeed, requires of its judges far-seeing and also microscopic eyes. How far do we by our treatment encourage these essential and scarce officers? The answer to this question is not satisfactory; there is undoubtedly a feeling akin to discontent. On the part of the Society there is a want of sufficient consideration; beyond a bed the judges have little to be thankful for. Such things as these that follow are not duly considered:—An over-crowded town; visitors considered fair game; lodgings

* I should like to read a clever paper on the great American agricultural gatherings.

where no refreshments can be had, and yet tired men must at night make and compare notes, for thoughts, like water spilt, may not be gathered up again. The judges absolutely require a quiet and convenient rendezvous. Then instead of giving the judges table money, and allowing them to consult their own convenience, quite regardless of distance and conditions of toil and dirt, we insist on handing them over for perhaps eight days or more together, to the tender mercies of a virtually uncontrolled showyard refreshment contractor, with his "bak'd meats coldly furnished forth." Surely the better plan would be to have a refreshment-room, good plain refreshments, with a duly posted tariff, somewhat as in the members' coffee-room of the Lords and Commons. Give table-money, say, stewards 5*s.* a day, judges 1*l.* 1*s.*, and let all pay. The judge, tired and toil-stained, it may be miles away from the show-yard, naturally says, "Why shall I not take mine ease at mine inn." In short, these are weighty matters. I should like to see a committee of three appointed to consider the whole subject; I have a high opinion of the importance of the offices referred to. I wish to see judges supplied with all appliances and means to boot; and I believe the best test of good and efficient regulations of stewards and judges is a host of cheerful and well-satisfied exhibitors.

Exhibitors are tried in the fiery furnace of competition; they are entitled to sympathetic consideration. It would be difficult to over-estimate the effects of free competition; the implement trade is now of world-wide interest; it is highly sensitive, as proved by the fact as stated, that the Society's admirable Report on Steam Cultivation has already advantageously affected the manufacturers of steam-cultivating tackle. There would appear to be phases of progress, periods of special growth, in the various departments of agricultural implements; for example, draining and tile-making, clod-crushing, reaping, steam cultivation, the gradual economy in the agricultural use of coal in the production of steam: the history of this last result, and the history of the reaper since the introduction of M'Cormack's reaper in 1851, might be suggestive. I cannot avoid touching on, but I will touch lightly, the vexed question of the prize system. Objectors to that system object chiefly for two reasons: they say trials are often unseasonable, often hurried. From their own stand-point these objectors have much reason. But looking all round the subject, there appears a consideration which, to my mind, is conclusive in favour of the prize system. Criticism depends on comparison. The prize system does not create competition; it brings it to a practical issue: there is no such thing as absolute perfection; but relatively, implements may be excellent. Contests

are annually becoming more keen. The results of the last steam contest must make steam-farmers wish that competing firms could make, not engines only, but drivers. To return to the immediate subject — exhibitors — they are not satisfied; and with reason. As Englishmen they willingly submit to constituted authority: they feel that time and chance happeneth to all; but they hate neglect and oversight, which after great preparation, made in accordance with published conditions, is naturally aggravating. They hate undue haste, and the appearance of undue haste. There is moreover a falling to the ground between two stools, or, in other words, between two classes of judges. It is a question how far judges by their awards influence purchasers? That they do influence purchases I cannot doubt, as the ordinary farmer requires a guide; if my observation is just, that criticism depends on comparison, then the judges, by the result of their comparisons, should influence purchasers. That judges sometimes suggest improvements is a fact within my own knowledge. Rotation is a law of nature; the rotation prize system, the triple division of 1856, works admirably, but perhaps requires extension. However that may be, further division of labour, especially in the Miscellaneous Class, is immediately necessary. Experienced stewards know that when there are many exhibitors who complain, there are more who are discontented; notwithstanding much may be done by patient hearing and sympathy with the mixed multitude. Indeed towards the last it became quite pleasant to go to and fro in the yard, and on recognising familiar and intelligent faces, to exchange friendly greetings.

My task is finished; only I would add two or three sentences, not by way of empty compliment, but to express a hearty feeling. For our great Society my wish is, may it ever be said "Age cannot wither her, nor custom stale her infinite variety." Of the honorary directory, need I say, I concur in the general feeling — one of unqualified respect. The judges, they who bear the heat and burden of the day, their disinterested labours, command our appreciation and deserve our thanks. I can see an eminent engineer judge, rain on one side, fire on the other, yet all day wearing an expression of pleasant humour, as though reflecting on "Man born unto trouble as the sparks fly upward." To my friendly colleagues, one and all, I am indebted for many agreeable and profitable hours: may I say, and trust the feeling is mutual, should old acquaintance be forgot? I do think a great charm of our meetings is, that they so tend to blend the sympathies of those whose best interests are really identical.

XXI.—*General Report on the Implement Show at Bury St. Edmunds.* By JOHN COLEMAN.

Nearly 5000 entries, occupying 282 stands, filling up, not merely the ordinarily allotted area, but streaming far over the space originally intended for the cattle classes, makes up an exhibit without parallel in the annals of the Royal Agricultural Society. This was, indeed, an attractive feature of the Show, and we cannot but hope that the results of the trials so patiently conducted, and a careful inspection of the long array of machinery of every kind here collected together will convey lessons, the fruits of which may be seen another day. We anticipated a great show, well knowing the enterprise of our leading firms, so many of whom are located eastwards. Before we enter into details, it may be desirable to mention that the Show-yard, enclosing some 42 acres, was well chosen, situated on the outskirts of the town, easily reached from the farthest points, approached by a broad drive, the visitor was set down before a neat and sensible-looking erection, comprising the Alpha and Omega (entrance and exit), Secretary's quarters, Post-office, &c. This building, which cost some 700*l.*, was so framed that it all takes to pieces, packs up easily, and, as soon as done with, goes into warehouse at Leicester, till required next year. The Show-yard, an irregular-shaped enclosure, partly composed of old turf and partly new-made grass, was on gently rising ground, the machinery in motion occupying great part of two sides, and making an extraordinary show. The railway accommodation was most inadequate, notwithstanding the erection of a siding in the yard, where machines and stock were at once delivered, provided they surmounted the previous difficulties. Great delays occurred both in bringing and removing the goods. The passenger trains were also much behind time, and had there been the rush of either Leeds or Chester, the results would have been lamentable; but all acquainted with the present state of the Great Eastern Railway were prepared to hear complaints, and really on the whole the Society may be congratulated on having got through a difficulty so well. The small accommodation afforded by the town, charming as it is in all other respects, the very insignificant quota of visitors it could itself furnish, led one to anticipate small results, even if the Show had been complete. The absence of horned stock made it a clear case from the first; the extent of the deficiency depending upon the weather, but under the most favourable circumstances a financial loss was inevitable. This, however, is of minor importance, provided the objects for which the Society has worked for a quarter of a century are

furthered. The collection of such a magnificent and ins
array of machinery could not fail to interest the East
farmers. The Trial of Implements, conducted with great
patience, and the results as detailed in the appended Repo
doubtless prove useful to intending purchasers. The exl
though they may condemn the system, which has in mai
proved their stepping-stone to fortune, with one or two
tions, rushed eagerly to the fray, and met their fate,
always do, like men; all cannot win, and defeat in suc
petition is not disgrace.

The Judges of Threshing Machines state that the
were generally very good, and so it happens that useful
ments remain unnoticed, simply because the results w
sufficiently perfect to win. A careful inspection of th
giving the preliminary trials in Classes B and C will pr
generally good was the work. Reference to the Report
Canterbury and Worcester Meetings, the two last occasio
similar machinery came into competition will show, th
former such threshing machines were tried as do not fini
which leave the corn to be acted upon by further pr
whilst at the latter all the money was bestowed on f
machines. The Council have acted wisely in now givin
for both, thus acknowledging the value both of the simpler
more complicated machinery under different circumstanc
Judges express a strong opinion in favour of the simpl
and farmers who thrash out of doors—a practice that
general in many districts—will generally endorse thei
The finishing machinery in many cases fulfills its purpo
but, as a rule, the crop is not sufficiently uniform to a
even sample as it leaves the machine, the motions
unsteady and irregular for good dressing, and the re
worth the power consumed.

With regard to Steam Engines, I regret to state
Judges' Report has not yet been received (October 3rd).

Report of the Judges on Threshing-machines.

We have to report a large entry in the following proportions:—

	Entries
Class A.—Horse-power Machines, the power not to exceed that of 4 horses	5
" B.—Portable Machines, not exceeding 8-horse-power, to be worked by steam, including any variety that does not profess to do more than prepare the corn for the Finishing-dressing machine ..	19
" D.—Portable combined Steam Threshing and Finishing Machines	14
Total	38

Class A.—Horse-power Machines.

We beg to submit for consideration of the Implement Committee that this prize be discontinued, and the money offered for a cheap and simple straw-elevator, or any other labour-saving application, in the Threshing Section. Horse-power machines, though still in use in some districts, are generally so indicative of a backward condition of agriculture, the process is altogether so clumsy, and the power consumed so great for the work performed, that we think it is a positive mistake to encourage by prizes machines that ought to be bye-gones in English agriculture. The plea may be raised that a large foreign demand still exists for these rude contrivances; it may be so, but this must yearly diminish as the advantages and economy of steam become more apparent. The primary object of our Society moreover, in offering prizes is to develope machinery valuable to the British farmer—the benefitting exhibitors being incidental.

The five competing machines were tested as follows:—A pulley being placed on the drum-spindle, each machine with horse-gear was driven through the dynamometer by one of Burrell's engines, the governors being adjusted for a slow speed; after putting through a few sheaves, to see that everything was in order, 100 sheaves were allowed, the time of threshing noted, the dynamometer indicating the total horse-power, from which the average horse-power per minute was ascertained. The results are recorded in the subjoined table:—

Class A.—Table No. 1.

	Number of Article.	Price Complete.	Time during Experiment.	Work Done.	Total Horse-power for 1 min.	Average Horse-power.
		£.	min. sec.			
Wallis, Haslam, and Stevens	4754	57	12 40	100 Sheaves of Wheat.	45·94	3·63
Tasker and Sons ..	4609	50	18 20	,,	72·40	3·95
Ransome and Sims ..	3562	60	14 47	,,	68·31	4·62
Turner and Fardon ..	627 and 628	55	4 30	,,	69·37	15·41
Woods and Cocksedge	2318	49	27 34	,,	60·82	4·40

No. 1. Wallis and Haslam's gearing is fitted with wrought-iron spindles and brass spherical bearings to reduce friction. The driving-wheel is large and strong; the horse-gear is on a frame running on four wheels, and is expeditiously packed up; the horse-poles appear to be too high to secure the easiest draft, a defect that may be easily put right; the drum, 3 feet 6 inches by 20 inches, is fitted with Goucher's beaters. Most of these machines would be improved if the slatted incline plane which receives the straw from the drum were lengthened, so as to allow a better chance for the separation of straw and grain; as it is, a vast quantity is brought over, and more or less wasted.

No. 2. Tasker and Sons entered a well-made, strong, and portable apparatus; the horse-work being carried on a frame with four high wheels, on which the drum is also packed; the horses work either in shafts or traces; the gearing is light, and the speeds well arranged; the straw is received on a travelling web, and thus elevated to a greater height, allowing more space for the grain to separate itself. An inclined slatted platform would be more effectual.

No. 3. Ransomes and Sims. The spindle is replaced by a cross strap, working through an intermediate motion; the drawing-wheel is in segments—supposed

to be an advantage in the event of a cog breaking. This, however, is doubtful; barn and horse-works carried on loose wheels; patent drum with six round twisted beaters; cast-iron bearings; the drum-frame altogether too small.

No. 4. Messrs. Turner and Fardon's machine is fitted with a drum capable of working far beyond the power of four horses; consequently 100 sheaves were slipped through in only 4½ minutes, consuming 15-horse power.

No. 5. Woods and Cocksedge's machine is a complete contrast to the last. It has a nominal 3-horse power; the drum is only 2 feet 6 inches long, and the feeding is a very slow, tedious business, as is evidenced by the time consumed over 100 sheaves.

We awarded to Messrs. Wallis, Haslam, and Stevens, First Prize, 12*l.*; to Tasker and Sons, Second Prize, 8*l.*

Class B.

The entries in this class, which includes all machines that only profess to prepare the corn for final dressing, were the most numerous and important; we are unanimous in considering that in portable machinery employed in the field, the complication of a separating apparatus is undesirable, the result obtained not being commensurate in any degree with the outlay of money and power. How seldom is the crop sufficiently even in quality to present an uniform sample throughout, and how impossible it is that the top, middle, and base of a stack, should be alike; lastly, how can sufficient steadiness of motion be secured when the fans and screens, which are depended upon for separating the corn, are all driven through the drum-shaft? Who has not felt the sudden check, and sometimes almost stoppage, of the drum from irregular feeding? And, when this occurs, the speed of the various parts of the machine is retarded, so that the fans do not blow out the chaff, the screens fail to separate the grain; hence we have, as our experiments fully prove, much tail-corn, chaff, &c. mixed with the head-corn, or else a fair sample is obtained at the cost of allowing much good corn to go over with the tail. If our readers will direct their attention to the power consumed by the single and finishing machines respectively, they may judge for themselves whether the result is worth the cost.

The restrictions of the Society as to the amount of horse-power consumed by these machines very materially affected our awards, putting out of court some excellent machines that otherwise might have been distinguished; the fewer the restrictions, either in live stock or implements, the more satisfactory to all parties are the awards. Still it is only reasonable to expect that for a single blast-machine an 8-horse-power engine should amply suffice. The conditions are well known to exhibitors, so that if they fail to comply with them they have no ground for complaint; nevertheless it must be very annoying to be thrown out owing to a small excess of draft.

Having an unusually large entry, and a limited time, our object was to give such a preliminary trial as would enable us to cull out the worst machines, and thus narrow the list for the final and conclusive test. A high shed, sufficiently large to hold two machines, was provided; under a second shed the dynamometer, on a frame with wheels, traversed by means of rails from one position to the other as required, a dummy, with band-wheels of similar diameter, enabling the authorities to get a second machine into place whilst the trial of the first was proceeding; the introduction of the dummy is a decided improvement over the Worcester arrangements, and when once we got into work no unnecessary delays occurred. Two of Burrell's 10-horse power engines, provided with three speeds for the governors, were employed to drive each machine; and very steadily they worked. Everything being ready, 10 sheaves were allowed to insure the straps, screws, &c., being in order. Then 100 sheaves were put through, time noted, the dynamometer indicating

the power consumed. During this trial we examined minutely the nature of the work, tabulating the results, as given in Table No. 2. As a rule, the corn was clean threshed, the machinery being nearly all supplied with Goucher's patent beaters, modified in a few cases. The corn was more or less broken in every instance, partly from the dry and free condition of the sample; noticeable differences occurred in the proportion of *Whitecoats*, &c., unthrashed; those machines furnished with a rubbing apparatus cleaned the corn most thoroughly. The separation of small seeds from the chaff, an important point, when the latter is used for food, appears to depend upon the combination of blast and screen. The general adoption of Coulson's spring suspenders, for carrying the caving-screens and winnowing-box (modified as to substance, some being equal throughout, others strongest in middle, thus making both ends elastic), is a decided improvement, both as reducing cost and lessening draft. The following table gives the results of the preliminary trial, and indicates the reason for our selection of machines for further competition. (See next page.)

In the second trial the following points were to be solved:—The weight of corn threshed during an interval of ten minutes; the proportion of grain not sacked, *i.e.*, scattered, left in the chaff, carried over with the straw, or under the machine (all of which must be more or less wasted in the field); the wheat in Whitecoats (also indicative of loss, since good large corn is sure to come over with these); and lastly, the weight of chaff and foreign matter in three bushels of the sacked corn; that machine was held to possess most merit which most completely separated chaff from corn, and left the separation of the different qualities of grain as the only work to be done by hand.

We proceed to notice briefly the different machines.

Marshall and Sons, Gainsborough: particularly steady in work, owing to solidity of frame and well-balanced driving gear. The corn is thoroughly rubbed by hummeller, and the chaff well blown away; altogether an excellent machine. Exceeding the limit of power, it is disqualified; but we should be wanting in fairness if we omitted to express the high opinion we all entertain of the merits of Messrs. Marshall's machine.

Humphries, of Pershore, fully justified the high reputation they have gained. Their chief merit is simplicity. The working parts are few, draft moderate, and liability to derangement reduced. The corn on its way to the hummeller is retained in the whitecoater-box, and subjected to the action of iron beaters revolving 500 times in a minute: hence the absence of whitecoats. The separation of weed-seeds is well done, the winnowing-box having a fine wire base through which dirt and seeds are shaken.

Ransomes and Sims have a strong open frame, well-strutted; a simple arrangement for bagging chaff without power; the bags, of peculiar shape, being suspended to the chaff-bonnet; Brinsmead's shakers, a series of bars revolving at right angles to the passage of the straw, furnished with teeth that interlap with those in front and behind, and thus carry on the straw by a continual agitation; the separation being rendered more perfect by the action of a puddler, which, with a pendulum motion, seizes the straw as it comes, retains and spreads it out, and so prevents it being jerked from the drum on to the middle of the shakers. This must be an admirable arrangement for barley. Reference to Table No. 3 will show the moderate power for work done. The winnowing process was not good, and admitted of some improvement, more chaff and heads being left in the sample than in any other case before us; this, together with the large proportion of *whitecoats* and the indifferent separation of weed-seeds from chaff, are defects that should be remedied. The safety-feeding hopper is noticed by the Miscellaneous Judges, we therefore refrain from more than a passing allusion. This novelty consists of a fence round the mouth of the drum, to prevent any person from falling in; in case any one "*the worse for liquor*" fell over the fence

Class B.—Table No. 2.

The Class of Portable Thrashing Machines not exceeding 8 horse-power to prepare the Corn for Dressing.

Name of Exhibitor.	Article.	Price.	Nominal horse-power.	Total horse-power for 1 min.	Average horse-power.	Time.	No. of sheaves.	Clean thrashed.	Clean shaken.	Cavings free from corn.	Chaff free from corn.	Chaff free from cavings.	Chaff free from seeds.	Straw unbroken.	Corn uninjured.	
No. of points incl. perfect work	..	..	..	..	..	..	..	100	70	70	50	20	20	50	20	Total 400
						′ ″										
Humphries, E.	4689	..	..	38·1	6·82	5 35	100	90	50	50	40	15	15	40	20	320
Boby, Robert	362	..	..	62·47	8·8	7 5	100	..	..	..	..	..	..	..	..	..
Marshall, Sons & Co. ..	4623	..	..	52·17	7·8	6 40	100	100	50	70	40	20	15	30	20	345
Ruston & Proctor ..	4685	..	..	63·25	10·39	6 5	100	70	40	60	40	20	15	20	5	270
Ransomes & Sims ..	3563	..	..	33·84	5·95	5 41	100	100	70	60	50	20	20	50	20	390
Clayton & Shuttleworth	4734	..	..	74·74	9·58	7 48	100	100	70	60	50	15	5	50	15	365
Robey & Co.	4773	..	..	58·82	8·75	6 43	100	100	60	60	50	15	..	50	15	350
Burrell, Charles	3070	..	..	45·85	9·11	5 2	100	90	60	60	50	20	15	40	12	347
Tuxford & Son	4648	..	..	68.61	11·7	5 51	100	80	50	40	30	..	..	40	15	255
Underhill, W. S.	4094	..	..	65·67	11·32	5 48	100	80	20	10	30	15	10	40	15	220
Wallis & Haslam	4755	..	..	58·21	9·09	6 24	100	90	60	70	50	20	15	40	20	365
Holmes & Son	3475	..	..	69·82	10·25	6 49	100	100	70	60	50	20	20	50	20	390
Nalder & Nalder	4788	..	..	54·51	6·97	7 51	100	85	50	10	50	20	15	50	20	300
Tasker & Sons	4610	..	..	94·00	17·60	5 20	100	60	60	30	50	20	15	40	15	290
Catchpool & Thompson	880	..	..	105·58	17·50	6 20	100	90	40	20	40	..	..	35	15	240

CLASS B.—TABLE No. 3.

Name of Exhibitor.	Number of Article.	Price.	Nominal Horse-power.	Actual Horse-power.	Horse-power for 10 minutes.	Corn Sacked.	Chaff, &c., removed from 3 bushels of Wheat by Winnowing.	Corn out of Sack.	Proportion of Whitecoats.	Steadiness.	Mechanical Construction.	Remarks
		£ s.				Stones of 14 lbs.	ozs.	lbs.	lbs.			
Marshall and Sons ..	4623	105 0	8	8·89	88·94	51·7¼	Not taken	2¼	5½	Very	Pulleys and bearings well fenced.	A capital Machine.
Humphries, E.	4689	90 0	6	7·21	72·14	41·2	3	1¾	None	Very	Well put together.	Second Prize of £12.
Ransomes and Sims ..	3563	105 0	8	7·75	77·56	61·2¼	17½	2¼	8	Very	Frame well stayed.	First Prize of £20.
Burrell, C.	3070*											
Holmes and Son	3475	100 0	8	9·68	96·82	52·4¾	Not taken	0¾	10½	Very		
Wallis and Haslam ..	4755	99 15	8	8·70	87·53	61·2	..	3				
Nalder and Nalder ..	4788	95 0	7	6·51	65·08	39·12	11	2¼	..	Fairly steady	..	Third Prize of £8.
Clayton and Shuttleworth	4734	100 0	8	8·97	89·73	46·4	..	1				

* Trial discontinued.

fence, a moveable iron grating is so arranged as to fall and close the mouth. In its present form this arrangement is rather inconvenient to the feeder, interfering with the regularity of the feed.

Nalder and Nalder's machine, which received the third prize is novel in some respects. The winnowing apparatus is driven by a simple eccentric, which appears to work well; the shakers are driven by a friction-pulley, and the travelling-wheels are of cast-iron with semi-hollow felloes.

It would be hardly fair to pass unnoticed the machines of Messrs. Holmes and Sons, Norwich, and Messrs. Clayton, Shuttleworth, and Co., Lincoln, although owing to the power consumed neither were eligible for the prize. The construction of both is good, the Lincoln firm being well known for the excellence of their workmanship, whilst Messrs. Holmes clean the chaff by a very simple arrangement. As both these makers will be referred to hereafter we abstain from further comment now.

Having the arrangement of the money in our own hands, we considered it desirable to award three prizes, viz. :—

First prize, Messrs. Ransomes and Sims.

Second prize, E. Humphries.

Third prize, Nalder and Nalder.

It is worthy of note that W. S. Underhill's machine was the only one fitted with his patent blast-elevator.

Class C.

In this class we have all those finishing machines that are supposed to dress up the sample ready for delivery. Eight entries came under consideration; the trials were on the same principle as before. Three bushels of the head-corn from each lot were passed through one of Boby's finishing-machines, as a test of merit. The quantity of light corn, &c., thus removed varies very considerably, and proves the correctness of our views as to the imperfections of these machines. No farmer who values his character as a good deliverer would like to offer such samples in a market. The following table give the results of the preliminary canter.

Messrs. Holmes and Son's machine, with the drum nearer the centre than is common, is well balanced, strongly made, and steady in its working. The corn is elevated to the top and above the shakers, and winnowed by a cross-blast, the winnowing-box having a face of fine perforated zinc wire; the dirt and seeds are blown away, the chaff is sacked well. To obtain this cross-blast either mitre-wheels or friction-wheels are necessary, the latter are used in this case: not, perhaps, the best mechanical arrangement, as these wheels and the shaftings are somewhat in the way and very unsightly, yet they are well balanced and work quietly. The box-shakers have edge-beaters, which tend to keep the straw up and thus assist the jerking action; they are driven by a double crank and connecting-rod. The rotary screen is regulated by a change of speed, sending the corn through with greater or less rapidity, according as much or little tail requires removal. Goucher's beaters are used, but in addition is a plain convex beater. A trap-door at end of the hummeller converts this into a single blower, if required.

In Clayton and Shuttleworth's machine the drum-spindle is attached to a strong bracket, which, although somewhat unsightly, steadies the drum and saves the brasses. Penny's screen is used. The workmanship is excellent, and the machine has a compact and trim appearance that looks like work. Everything is made as simple as is practicable.

The table given at p. 600 embodies the facts arrived at, and will sufficiently explain the reasons for our decisions.

Class C.—Table No. 4.

For the Class of Steam Portable Thrashing and Finishing Machines.

Name of Exhibitor.	Article.	Nominal horse-power.	Total horse-power for 1 min.	Average horse-power.	Time. ′ ″	No. of sheaves.	Clean thrashed.	Clean shaken.	Cavings free from .	Chaff free from corn.	Chaff free from cavings.	Chaff free from seeds.	Straw unbroken.	Corn uninjured.	
No. of points incl. perfect work	..	..	..	..	..	..	100	70	70	50	20	20	20	50	Total 400
Humphries, E.	4688	..	35·92	5·9	6 5	100	90	30	40	50	20	20	15	40	305
Barrows & Co.	4614	..	40·98	8·19	5 0	100	100	20	70	50	20	..	15	..	275
Marshall & Co.	4624	..	35·37	6·9	5 5	100	100	50	70	40	20	15	20	40	355
Ruston & Proctor	4680	..	58·64	9·8	5 56	100	20	40	70	50	20	15	15	50	280
Turner, E. R. & F.	2234	..	56·91	9·62	5 55	100	80	60	65	50	20	..	20	45	340
	2235	..	43·84	5·29	8 17	100	70	50	60	50	20	..	15	40	310
Ransomes & Sims	3566	..	38·19	7·37	5 11	100	90	70	70	50	20	20	20	45	385
Gibbons, P. & H.	4582	..	60·02	10·99	5 38	100	100	50	70	40	15	..	20	30	325
Clayton & Shuttleworth ..	4735	..	68·08	11·8	5 46	100	100	70	70	50	15	..	15	50	370
Robey & Co.	4774	..	47·13	7·85	6 0	100	100	20	70	50	20	10	15	30	315
Burrell, C.	3069	..	48·78	9·6	5 3	100	100	60	60	50	20	20	15	20	345
Tuxford & Son	4649	..	48·82	10·8	4 35	100	10	20	40	30	20	..	10	40	170
Underhill, W. S.	4095	..	68·04	11·24	6 3	100	70	30	50	30	15	10	15	40	260
Holmes & Son	3477	..	60·61	8·32	7 17	100	90	70	70	50	20	20	20	50	390
Wallis & Haslam	4756	..	62·07	10·2	6 5	100	90	60	30	50	20	15	20	45	330
Tasker & Son	4611	..	76·04	10·77	7 4	100	100	60	40	50	20	20	20	40	350

CLASS C.—TABLE No. 5.

Name of Exhibitor.	Number of Article.	Price.	Nominal Horse-power.	Actual Horse-power.	Horse-power for 1 minute.	Best Corn.	Seconds.	Thirds.	Tail out of 3 bushels of head by hand winnowing.	Whitecoats.	Mechanical Construction.	Remarks.
		£ s.				Stones of 14 lbs.	lbs.		ozs.	lbs.		
Ransomes and Sims ..	3566	130 0	8	8·12	81·24	47·0½	9½	..	58	3½	Steady and strong.	
Gibbons, W. and H. ..	4582	112 0	7	8·99	89·9	37·4½	20¼	4¼	54	..	Mitre wheels noisy.	
Marshall and Sons ..	4624	115 0	8	9·10	91·06	39·1	23¾	4¼	41	11¼	Good	Third Prize of £5.
Clayton and Shuttleworth	4735	115 10	8	10·78	107·86	40·6¾	20¾	15¼	32	0¼	Excellent	Second Prize of £15.
Holmes and Sons ..	3477	120 0	8	9·3	93·07	35·5¼	8	4¼	11	..	Good	First Prize of £20.
Tasker and Sons	4611	105 0	8	12·1	121·2	42·3	12¾	8¼	56	6¾	,,	
Ruston and Proctor ..	4680	125 0	8	12·7	127·59	37·13¾	56½	13¼	19½	1¼	,,	

Our award was as follows:—
First prize, Holmes and Sons, 20*l*.
Second prize, Clayton and Shuttleworth, 15*l*.
Third prize, Marshall and Sons, 5*l*.

Amongst the novelties at Bury, one of the most interesting was Mr. Daniel Crowe's portable 7-horse power thrashing-machine, with engine combined. It closely resembles an ordinary threshing-machine in appearance, the engine-works being at one end, with the boiler placed underneath, but so enclosed in the framework that the tall chimney alone suggests the notion of steam. Weighing 7 tons 1 cwt., it travels with perfect ease, and, having the fore-wheels placed under the carriage, turns in its own area with rapidity. The steerage is very simple, and, if strong enough for stony roads, admirable. Mr. Crowe, who hails from King's Lynn, Norfolk, brought his apparatus from Towcester, in Northamptonshire, to Bury St. Edmunds, 84 miles, consuming, as he states, only 16 lbs. of coal per mile. The fire and boiler are both carefully shut in; the latter, though near the ground, is never sufficiently hot to be dangerous; indeed, Mr. Crowe states that he has purposely surrounded it with straw and chaff whilst thrashing. The drum is not driven direct from the fly-wheel, as in ordinary cases; and thus the speed of the drum can be altered to suit the corn, whilst the other parts of the machine are working at a fixed speed. One strap drives both dressing part and shakers, and a V-groove friction-wheel is employed to drive the fan; all the straps are under cover, and are not easily affected by weather. The rapidity and ease with which the machine is placed in position and set to work offers a marked contrast to the loss of time that invariably occurs in fixing an ordinary portable engine and threshing-machine. We were at first apprehensive of accidents from the proximity of the fire to the straw, but, after trial, are satisfied that there need be no more risk than with a common engine. We set Mr. Crowe to work on some inferior wheat, which had been objected to as not good enough for the trials, being much blighted, and the straw in consequence rotten. In 9 minutes 44 stones of well-blown but much broken wheat was thrashed, the waste under and about the machine being absolutely nil. The breaking was caused by the drum being set rather too close at the top. Several loads of barley having been thoroughly soaked by the rain on Monday were offered to some of the makers, but declined. Crowe steamed up to the stack, steered through a narrow space, set to work, and threshed it marvellously well—no doubt in consequence of the greater speed at which the drum was driven; the cavings were all but free from corn. It is, therefore, quite evident that we have a practical and efficient combination, capable of some improvements in detail, but of great use for letting out. The price, 380*l*., appears very moderate.

In concluding our Report we desire to tender our best thanks to the Implement Stewards for their kind attention to all our wants, and also to Mr. James Amos for the patient and unflagging attention with which he conducted the dynamometic experiments, and for his assistance in carrying out the trials.

H. B. Caldwell.
John Brasnett.
Thomas Scott.
John Coleman.

This excellent and comprehensive Report may be supplemented by a few remarks touching the arrangements at Bury, with a view to improvements in the future. The importance of the verdict to the exhibitors may be judged of from the anxiety evinced to secure the prize, and the extreme jealousy that prevails as to impartiality. Seeing, then, that Implement-makers are

willing to undergo great outlay, and submit to great inconvenience, it behoves our Society to be careful that the trials are conducted in such a thoroughly conclusive manner that no one can fairly complain, but all, whether beaten or successful, must acknowledge the fairness and completeness of the ordeal. Now, the first requisite is time; nothing can be well done if done in a hurry; and when judges have to deal with such an array of implements as at Bury, and have only 3½ days as the given time, one of two consequences is inevitable, either the trials are hurried over, and the risk of error greatly increased, or else, as in the present case, the awards are not published until the show is half over, and the successful exhibitor forfeits all the advantages he would derive from publicity. The implement awards should be lodged with the Secretary on the Saturday night, and according to the entry, which is known in May, the time allowed for judging should be determined. We dwell on this point, remembering the facts relating to the Newcastle trials of steam cultivators. Work commenced on the Tuesday, weather fine throughout; yet, notwithstanding great exertions on all hands, the awards were not made public until the Tuesday afternoon in the show week. It is possible that the entries at Leicester next year may exceed those at Newcastle, and just in that proportion should the date of the trials be put forward. The second point to which we would direct attention, is the importance of securing uniform conditions during the trial of a class of machines in competition for the same prize. The weather at Bury was splendid until noon on Saturday, the 13th, when a sudden and very heavy thunderstorm caught the corn in rick and in the waggons; consequently, when the judges again got to work, a protest was raised on account of the condition of the corn, and it was with difficulty that some comparatively dry sheaves were picked out; but some of them were slightly damp; and it is evident that the trials after such rain could not take place under exactly similar conditions. Moreover, very serious delay occurred from rain. The risk of such delay might be easily remedied by extending the machine shed, say 12 feet on each side, filling these spaces with well-tied sheaves previous to the commencement of the trials. The next spaces to receive the machines should be 9 feet wide, whilst a clear space of 15 or 18 feet in the centre of the shed would divide the two machines, and allow of ample space for collecting the products of the experiments, winnowing the samples, &c. At Bury the shed-room was only sufficient to hold two machines, the corn being brought on carts as required. The cost of the extra roofing would be more than repaid in the saving of labour in carting the sheaves from the stack to the machines; uniformity of conditions would be secured, whilst the risk of serious

hindrance from rain would be avoided. We further think that the trials of food preparing machinery would be more satisfactory under cover.

Some objection was taken to the validity of the thrashing trials, not by exhibitors, but observers, on the ground that such important decisions demanded a much larger trial, that instead of 100 sheaves and 10 minutes, each machine should have set down to half a day's work, and then the results would have been of value; but would this be so? we think not; every fact connected with the working powers of the machine was as clearly visible in the run for 10 minutes as in 10 hours, and each exhibitor had been previously allowed ample opportunities to adjust the various portions of his machine, according to the condition of the corn.

It is to be regretted that no premium was offered for Straw Elevators in connexion with thrashing machine trials; the difficulty of obtaining hands is increasing every year, and certainly the Elevator does the work of two men; hitherto the price has been too great considering the simplicity of the apparatus; we are glad to see that both Messrs. Hayes and Son, and Amies and Barford, have somewhat reduced their prices, though there is room for further alteration. We hope to see these machines sold at 30*l*. The power consumed by the best is very small, probably varying from $\frac{1}{4}$ to $\frac{3}{4}$ of a horse power.

Report on Power-driven Chaff Cutters, Mills, &c.

THE Implements tried by us were all well adapted to be driven by Steam, or Horse Power, viz.:—Chaff Cutters; Grinding Mills, with stone grinders for grinding agricultural produce into meal; Grinding Mills, with metal grinders for grinding agricultural produce for feeding purposes; Linseed and Corn Crushers; Oilcake Breakers for large and small cake; Bone Mills; Roo Pulpers.

CHAFF CUTTERS. We had sixteen for trial, and we gave each machine one cwt. of very dry rough wheat straw for the first, and 70 lbs. of rough hay to a few of the best machines for a second trial. See Table I.

GRINDING MILLS, with STONE GRINDERS. We had eight for trial, we gave each mill some barley for a preliminary trial to adjust the stones, then 56 lbs., and took time, &c., as below. See Table II.

GRINDING MILLS, with METAL GRINDERS. We tried eight, our rule was to give to each mill $\frac{1}{2}$ cwt. of Indian corn, then $\frac{1}{2}$ cwt. of barley. We made two exceptions; to one mill, because of the superiority of its performance, we gave $\frac{1}{2}$ cwt. of wheat and $\frac{1}{2}$ cwt. of linseed, all of which it did equally well. See Table III.

LINSEED and CORN CRUSHERS. We tried ten with 28 lbs. of linseed, and 84 lbs. of oats each. See Table IV.

OIL CAKE BREAKERS. Sixteen were tried with $\frac{1}{2}$ cwt. to each machine for breaking both fine and coarse. The time and power was taken while breaking the cake fine. See Table V.

BONE AND BONE DUST MILLS. We tried only four, three of which worked remarkably well. See Table VI.

ROOT PULPERS. Twelve tried, each with 1 cwt. of mangold. See Table VII.

TABLE I.—CHAFF CUTTERS.

Name of Exhibitor.	Number of Stand.	Number of Article.	Price.	Quantity of Straw Cut.	Time in Minutes and Seconds.	Revolutions of Dynamometer.	Horse-power per Minute.	Average Horse-power.	Remarks.
			£ s. d.	lbs.					
Richmond and Chandler..	2	13	15 19 0	112	2 35	5·23	2·948	1·142	£10 Prize.
Bentall	79	1476	12 1 0	112	2 21	10·28	5·794	2·466	£6 rize.
Picksley, Sims and Co. ..	124	2768	13 16 0	112	3 18	12·88	7·260	2·20	£4 Prize.
Carson and Toone	26	517	14 5 0	112	4 17	12·25	6·905	1·612	Highly Commended.
Page and Co.	96	2045	14 14 0	112	4 42	14·57	8·213	1·747	Commended.
Cornes	60	1051	13 0 0	112	2 57	10·8	6·087	2·063	Commended.

The time, power, &c., was taken while cutting the straw.

TABLE II.—GRINDING MILLS WITH STONE GRINDERS.

Name of Exhibitor.	Number of Stand.	Number of Article.	Price.	Quantity Ground.	Time in Minutes and Seconds.	Revolutions of Dynamometer.	Horse-power per Minute.	Average Horse-power.	Remarks.
			£.	lbs.					
E. R. and F. Turner ..	104	2238	55	56	7 36	51·57	29·070	3·825	£9 Prize.
John Tye and Co.	52	928	55	56	3 4	80·0	45·096	14·708	£6. (On four wheels.)
Ruston, Proctor and Co.	250	4684	55	56	6 40	57·5	32·412	4·866	Commended.

TABLE III.—GRINDING MILLS WITH METAL GRINDERS.

Name of Exhibitor.	Number of Stand.	Number of Article.	Price.	Quantity and Material.	Time in Minutes and Seconds.	Revolutions of Dynamometer.	Horse-power per Minute.	Average Horse-power.	Remarks.
			£ s. d.						
Amies and Barford	84	1629	24 0 0	56 lbs. barley	3 9	50·91	28·697	9·11	£20 Prize.
Thompson and Stather* ..	238	4606	16 0 0	28 lbs. barley	4 17	.. ..	..	..	Not well done, the husk only shreaded.
				28 lbs. Indian corn	2 45	.. ..	..	..	Very well done.
				28 lbs. oats	1 55	.. ..	..	..	Ditto ditto
				28 lbs. beans	1 40	.. ..	..	..	Broken too fine.
				23 lbs. locust beans	2 15	.. ..	..	..	Very well done.
				28 lbs. linseed	1 12	.. ..	..	..	Nearly all broken.
				28 lbs. linseed	4 50	.. ..	..	..	Broken very fine.
				28 lbs. of $\frac{3}{8}$-inch bones	3 43	.. ..	..	..	Broken to dust.

* This mill performed remarkably well, being driven at a very high velocity—about 3000 revolutions per minute—it is of a new construction.

TABLE IV.—LINSEED AND CORN CRUSHERS.

Name of Exhibitor.	Number of Stand.	Number of Article.	Price.	Quantity and Material.	Time in Minutes and Seconds.	Revolutions of Dynamometer.	Horse-power per Minute.	Average Horse-power.	Remarks.
			£ s. d.						
Woods and Cocksedge ..	105	2279	15 0 0	28 lbs. linseed	3 27	7·43	4·188	1·213	Prize £8.
				84 lbs. oats	5 17	12·	6·764	1·281	
E. R. and R. F. Turner ..	104	2243	12 17 6	28 lbs. linseed	2 27	6·05	3·4103	1·392	Prize £7.
				84 lbs. oats	5 58	13·15	7·4126	1·343	

TABLE V.—OIL CAKE BREAKERS.

Name of Exhibitor.	Number of Stand.	Number of Article.	Price.	Quantity.	Time in Minutes and Seconds.	Revolutions of Dynamometer.	Horse-power per Minute.	Average Horse-power.	Remarks.
			£ s. d.	lbs.					
Amies and Barford	84	1638	7 2 0	56	0 46	0·32	0·1803	0·235	£10 Prize.
Bentall	79	1498	7 19 0	56	1 10	3·77	2·125	1·822	£5 Prize.

TABLE VI.—BONE AND BONE DUST MILLS.

Name of Exhibitor.	Number of Stand.	Number of Article.	Price.	Quantity.	Time in Minutes and Seconds.	Remarks.
			£ s. d.	lbs.		
Beverley Iron and Waggon Company	95	2016	210 0 0	392	9 0	£10 Prize.
	95	2017	85 0 0	.. ..	5 30	£6 Prize.
	95	2018	95 0 0	.. ..	.. ..	£4 Prize, a very good bone dust mill.
W. Croskill and Sons	48	910	85 0 0	.. ..	.. ..	Broke during trial.
Ditto Elevators extra ..	..	..	5 0 0			

We could not test these mills with the dynamometer, but we were perfectly satisfied with the trials.

TABLE VII.—ROOT PULPERS.

Name of Exhibitor.	Number of Stand.	Number of Article.	Price.	Quantity.	Time in Seconds.	Revolutions of Dynamometer.	Horse-power per Minute.	Average Horse-power.	Remarks.
			£ s. d.	lbs.					
Hornsby and Sons	63	1594	6 6 0	112	36	0·65	0·3664	0·610	£6 Prize.
Bentall	79	1512	5 15 0	112	33	0·75	0·4227	0·768	£4 Prize.
Ransomes and Sims ..	150	3603	6 6 0	112	..	.. ..	..	..	Highly Commended.

One hundred and forty-three trials on seventy-six articles were made by us exclusively of the preliminary trials and stoppages,—the results were mostly very satisfactory, except in the case of mills with stone grinders; in these the chief difficulties were caused by the great weight of the mills, and it was also hard to apply the proper speed, most of them having their pullies too small, and some of the exhibitors, or their men, were in too great hurry, and so much overfed the mills that the dynamometer was loaded beyond its power.

We beg to suggest that when these machines again come to trial, better arrangements be made for attaching the machines to the dynamometer, as a great deal of time was lost in moving them and getting them ready for trial. The platform should be level all round, so that a machine can be put on it on any side. We recommend also that a shed be erected so that the trials be made under cover, as much inconvenience was experienced from not being sheltered from the wet.

The stone mills should be brought to trial on four wheels.

John Hicken, Dunchurch, Rugby.
James Martin, Wainfleet, Lincolnshire.

The absence of detail in the above Report renders a few particulars desirable; Messrs. Richmond and Chandler, who are once again ahead of all competitors with chaff cutters, have introduced spiral springs on each side of the box, by which the feed is pressed down in place of the lever and weights, which are troublesome to regulate. Another novelty by the same firm consists in the introduction of a travelling chain on the bottom of the box, which draws the feed forward, and materially reduces the labour of the attendant, a useful addition to the larger machines.

Messrs. Picksley and Sims, well known as good makers, exhibit several novelties, principally an arrangement by which clutches are substituted for ordinary change-wheels, so that alteration in the length of cut can be made whilst the machine is in motion. Messrs. Carson and Toone have a simple arrangement for sacking the chaff, particularly useful where operations are conducted out of doors, not unfrequently the case in large sheep farms. The average horse power appeared to be moderate.

Metal grinding-mills are a particularly interesting and important class, which appears for the first time at a Royal trial. At Newcastle the miscellaneous judges awarded a medal for Amory Felton's American mill. This has been much improved upon in several particulars, and Messrs. Riches and Watts, Amies and Barford, and others, have made and sold large numbers since. So far as we can learn they have generally given satisfaction. The wear of the grinding surfaces, both cylinders and breasts, is considerable, but as the cost of the former is only 3*l.*, and the latter 30*s.*, the outlay is not excessive when we consider that, with proper care as to absence of stones, from 700 to 1000 quarters of corn may be ground without renewal. Mills of this class supply a want long felt by those whose occupations are not large enough for stone

mills. The American mill consists of a fluted barrel cone-shaped, the surface of the best chilled metal, revolving in contact with similarly fluted breasts; the corn enters at the upper end of the mill, and is passed round and round until it is delivered as fine or coarse meal, or only kibbled, according to the proximity of the breasts to the grinding surface. The rapidity with which ordinary work can be performed, the moderate power consumed, and the comparatively low price, are points in favour of these machines.

Messrs. Turner and Fardon's mill is probably more ingenious than practical; a spiral screw runs from end to end above the barrel, revolving independently; this screw passes the corn forward after being carried round by the barrel, and the rapidity with which it is driven determines the coarseness or fineness of the sample. The power was too great, and the corn handled quite warm. The judges mention 8 machines as entering for trial, yet the results are only given in 2 cases, a matter of regret, as exhibitors are generally anxious to learn all they can as to the draft of their machines.

The novelty in the mill class is the patent crusher exhibited by Stather and Thompson of Hull, which has been used largely, and with great success, to crush cotton seed, grind locust beans, and palm kernels. The peculiarity consists in the fact that the work is done without contact. The iron beaters, which resemble the arms of a whitecoater in a thrashing machine, are not within an inch of the ribbed concave, against which the corn is thrown and broken by centrifugal force, caused by the beaters revolving some 3000 times per minute. This mill is simplicity itself, consisting of a narrow cylindrical box, into which the corn is admitted above and escapes through the meshes of the wire slides which form the sides, and are altered according to the nature of the article and the fineness of sample required. It is quite evident from the trials we witnessed that any hard dry substance must be reduced, but we apprehend difficulty with soft damp corn, and it will be noticed that the barley was not well ground, while other harder substances were thoroughly reduced. Bones were speedily made into powder, and samples of coprolites were shown, although we did not see them ground. We understand from the judges that the power consumed for a given quantity did not greatly exceed that of the prize metal mill, but a much longer time is required. This is an objection, and we are led to conclude that this highly ingenious machine is not in its present form so well adapted for a farmer's use as either an American metal mill, or a good pair of Burr stones. The fittings were evidently rude, and might be considerably improved. We regret that the judges have not given the power consumed in these trials, and entered more generally into details.

Although ineligible for the prize, and therefore not brought to trial, we must notice C. Burrell's Portable Mill for grinding coprolites, as an implement much valued by large occupiers in the Eastern Counties, who employ coprolites largely as the base of their turnip manure, and who still consider they can make a good article at a lower figure than that at which it is sold. The 4 ft. 6 in. French stones, built on edge, produced a capital sample. Price, 130*l.*

Report on the Hand-power Machines.

It will not be necessary to attempt an elaborate detail of the trial of hand-power machines. There was little novelty to describe, and provided the implements were strong and simple in construction, the dynamometer affords evidence of peculiar importance in guiding us to our decisions.

Corn-Dressing Machines.

We felt no difficulty in awarding these prizes; the two winning machines producing with great ecomony of time and less power samples very superior to all the others. The division of corn in Tasker's machine was exceedingly good, giving an excellent sample with only a modicum of good grain in all the collected offals. The merits of Corbett's dresser was scarcely inferior: whilst in several of more costly and complex structure the quantity of good grain in the spouting was sadly in excess of what should be found there. Each machine had a preliminary trial, and re-adjustment was made when required. Two bushels of wheat were allowed for each experiment.

The following tables of dynamomical results cannot fail to be interesting, and we tender our cordial thanks to Mr. Knight, our attendant engineer, for his valuable services. If, on examination, these tabulated forms be found, seemingly, not to agree throughout with the awards, it should be noted that speed and lightness of draught would not in themselves assign the first position, if defect in strength, and want of simplicity in the construction of the working and wearing parts, or inferiority of sample produced, counteracted those admitted advantages.

Quantity, 2 bushels Wheat.

Name of Maker.	Article.	Time.	Revolutions.	Power (in foot lbs.).	Price.	Remarks.
		′ ″			£. s. d.	
John Baker	41	1 55	73	6,360	9 10 0	
Benjamin Kittmer ..	71	1 26	51	5,305	9 0 0	
R. and R. Hunt	650	2 30	87	4,530	8 8 0	
Page and Girling ..	706	1 32	54	6,550	9 10 0	
Robert and J. Reeves	752	1 28	52	4,530	10 10 0	Commended.
S. Corbett and Sons ..	992	1 7	34	1,850	9 5 0	Prize £8
Murton and Turner ..	1409	2 10	75	13,230	11 11 0	
Holmes and Sons ..	3483	1 27	49	8,470	8 10 0	
Tasker and Sons ..	4612	0 54	32	4,005	9 10 0	Prize £12
Robert Boby	328	2 33	84	12,260	15 0 0	
William Smith	57	2 35	88	10,560	9 9 0	
Ransomes and Sims ..	3571	1 46	61	6,630	10 0 0	Commended.

Corn Screens.

In this division of implements, the rapidity of the work, the lightness of the power, the simplicity of the construction, and the decided superiority of

the sample produced by Hornsby's screen removed every doubt as to the award. This new rotary screen consists of a simple cylinder of coiled wire, like the ordinary fixed-mesh screens that have been long used, but instead of the cross-bars being placed longitudigally, they are placed diagonally, in a serpentine form, and each separate coil of wire is lapped or bound round the outside of them in the ordinary way of wire-stitching. Then by bringing the adjusting screw to act upon the whole cylinder it is contracted or expanded equally from end to end, and thus easily adjusted to suit grain of any size. The large and cumbersome sheet-iron screw, formerly used to conduct the grain along and to diffuse it over the screening surface is dispensed with, the inner serpentine bars answering the same purpose, and thus giving lightness and strength, great simplicity with durability. This machine affords a large screening surface without complication of parts.

Quantity, 2 *bushels Wheat.*

Name of Maker.	Article.	Time.	Revolutions.	Power (in foot lbs.).	Price.	Remarks.
		′ ″			£. s. d.	
Robert Boby	338	2 25	83	6555	9 9 0	Commended.
Penney and Co.	.1311	3 53	133	6720	14 14 0	Commended.
Nalder and Nalder ..	4791	1 36	56	3965	10 10 0	
Richard Hornsby and Sons	1584	1 4	36	2905	11 0 0	rize £10
J. T. Poyser	3576	3 58	136	7900	22 1 0	
Coleman and Morton	731	3 40	126	6050	12 12 0	
R. and J. Reeves ..	753	1 52	64	2960	8 0 0	
Ransomes and Sims ..	3573	3 31	121	2730	12 12 0	Commended.

Three competitors being very anxious to have their screens tested with *barley*, we allowed the competition, supplying each with one bushel for the trial. The sample produced from the same description of rough corn was decidedly in favour of Mr. Boby's screen; but this second experiment more fully convinced us of the already proved superiority of principle and construction in Hornsby's, with its ready adaptation and its ample cylinder. Mr. Poyser's machine indicates the clever and ingenious mind of its inventor: its value is no doubt duly appreciated in the celebrated granaries at Burton, but when placed on the same lower but level trial-ground at Bury, we failed to discover preponderating merit, for in the trial both of wheat and barley the division of corn was *not* made as described, "*in the most perfect manner!*" Much good grain was delivered in the spoutings, and the sample was decidedly inferior to Mr. Boby's. Mr. Poyser's screen, however, deserves honourable mention for some clever and peculiar arrangements for separating both broken corn and coarser substances from the best grain; still the implement requires great power and hardly produces a corresponding advantage in the sample.

Trial with Barley (1 *bushel*).

Name of Maker.	Article.	Time.	Revolutions.	Power (in foot lbs.).	Price.	Remarks.
		′ ″			£. s. d.	
J. T. Poyser	3576	2 36	89	6045	22 1 0	
Penney and Co... ..	1312	1 48	62	3360	12 12 0	
Robert Boby	341	1 19	43	5200	15 10 0	Highly Commended.

BARLEY HUMMELLERS. (*Quantity*, 2 *bushels.*)

Name of Maker.	Article.	Time.	Revolutions.	Power (in foot lbs.).	Price.	Remarks.
		′ ″			£. s. d.	
Robert Boby	354	4 54	133	15,360	5 0 0	
Holmes and Sons ..	3485	2 28	90	5,670	4 10 0	Prize £5

CHAFF CUTTERS.

The arrangement of the working parts in Richmond and Chandler's, and Bentall's machines was beautiful, combining great strength with much simplicity. A provision for altering the lengths of chaff by changing the position of the wheels without removing the wheels themselves was admirable. Smith and Grace showed a very excellent chaff cutter, and produced a sample equal to any one of their clever compeers. Their machine was eminently simple in construction and low in price; but it was beaten both in time and power by the machines to which we unhesitatingly awarded the prizes, feeling sure that where a large quantity of chaff has to be provided they would be found the cheaper articles, because of the great strength, admirable adaptation, and the saving of power and time required to produce a given quantity. If we had had more money at our disposal we should certainly have apportioned some of it to Smith and Grace for their very good little hand-power chaff cutter.

Quantity, 28 *lbs. Straw.*

Name of Maker.	Article.	Time.	Revolutions.	Power (in foot lbs.).	Price.	Remarks.
		′ ″			£. s. d.	
Joseph Warren	389	5 40	195	25,220	4 14 6	
Edward Hammond ..	1462	4 27	150	25,250	5 5 0	Prize £4
The Reading Iron Works	2510	5 40	190	26,810	5 15 0	
Hunt and Pickering ..	1766	7 22	249	24,945	5 5 0	
Picksley, Sims, and Co.	2765	7 3	241	41,350	7 0 0	
James Cornes	1052	6 4	207	22,960	4 15 0	
Carson and Toone ..	521	5 11	174	30,275	5 10 0	
Richmond and Chandler	11	4 10	142	15,070	7 7 0	Prize £6
Smith and Grace ..	772	5 28	193	26,825	3 10 0	Highly Commended.

GRINDING MILLS.

The labour of producing fine meal with grinding and crushing mills worked by hand-power was necessarily protracted and severe. These trials brought vividly to mind a remark by the late lamented editor, Mr. Pusey,—" If you once establish a moving power on your farm, whether steam, water, or wind, it is not the labour only of thrashing that may be saved to men or horses, but the winnowing, the dressing, the chaff-cutting; even the turnip-slicing machine, when the turnip is consumed at home, may be grafted on the principal wheels and thus borrow their motion. The more labour is thus set free

from mere work of routine, the more will be applied to the further improvement of the parent of all agricultural labour—the soil." *

Trial with Barley (1 *peck*).

Name of Maker.	Article.	Time.	Revolutions.	Power (in foot lbs.).	Price.	Remarks.
		′ ″			£. s. d.	
Hunt and Pickering ..	1771	17 2	510	52,345	4 10 0	
Samuel Corbett and Son	996	12 58	364	64,350	5 5 0	
Smith and Grace ..	773	11 10	255	93,430	5 5 0	

Trial with Beans (1 *peck*).

		′ ″			£. s. d.	
Hunt and Pickering ..	1771	5 17	151	23,430	4 10 0	
Samuel Corbett and Son	996	4 8	120	25,350	5 5 0	Prize £4.
Smith and Grace ..	773	3 20	105	15,620	5 5 0	Prize £6.

CRUSHING MILLS.

These mills were all good mills, and varied very little in the samples they produced. The decision was rather puzzling, and until we got some assistance from the faithful register of time and power furnished by the dynamometer our deliberations—

> " Like diff'ring doctors, serv'd but to declare
> That truth lies somewhere, if we knew but where ! "

Trial with Linseed (1 *peck*).

Name of Maker.	Article.	Time.	Revolutions.	Power (in foot lbs.).	Price.	Remarks.
		′ ″			£. s. d.	
Edward Hammond Bentall	1480	6 6	174	48,325	5 5 0	
E. R. and F. Turner..	2245	8 8	258	31,570	8 15 0	
Woods and Cocksedge	2287	6 3	178	36,585	5 10 0	

Trial with Oats (2 *pecks*).

		′ ″			£. s. d.	
Edward Hammond Bentall	1480	10 8	317	53,535	5 5 0	Prize £6.
E. R. and F. Turner ..	2245	8 45	270	40,050	8 15 0	Prize £4.
Woods and Cocksedge	2287	13 22	409	62,525	5 10 0	Commended.

* 'Journal Royal Agricultural Society of England,' Vol. I., p. 16.

CAKE BREAKERS. (*Trial with* 14 *lbs., crushed fine.*)

Name of Maker.	Article.	Time.	Revolutions.	Power (in foot lbs.).	Price.	Remarks.
		′ ″			£. s. d.	
Edward Hammond Bentall	1492	1 35	50	4000	3 3 0	
Hunt and Pickering ..	1773	1 57	60	2700	3 10 0	
Coleman and Morton	733	1 2	32	3950	4 4 0	
Woods and Cocksedge	2302	2 12	70	4340	3 5 0	
Holmes and Sons ..	3490	1 6	35	2630	4 15 0	
R. and R. Hunt	654	1 48	56	3000	3 3 0	
S. Corbett and Son ..	998	1 20	40	4925	3 10 0	
Richard Hornsby and Sons	1586	0 36	19	1825	5 0 0	
E. R. and F. Turner ..	2259	1 35	49	4390	4 15 0	
E. Page and Co. ..	2050	2 12	70	3505	3 15 0	

Trial with 14 *lbs., broken coarse.*

Name of Maker.	Article.	Time.	Revolutions.	Power (in foot lbs.).	Price.	Remarks.
		′ ″			£. s. d.	
Edward Hammond Bentall	1492	0 57	30	1840	3 3 0	Prize £5.
Hunt and Pickering ..	1773	1 30	45	2075	3 10 0	
Coleman and Morton	733	1 8	36	1525	4 4 0	
Woods and Cocksedge	2302	1 1	42	3440	3 5 0	
Holmes and Sons ..	3490	0 40	21	1560	4 15 0	
R. and R. Hunt	654	0 43	22	1660	3 3 0	Prize £5
S. Corbett and Son ..	998	0 50	23	3540	3 10 0	
Richard Hornsby and Sons	1586	0 33	16	905	5 0 0	
E. R. and F. Turner ..	2259	1 32	48	2025	4 15 0	Commended.
E. Page and Co. ..	2050	1 13	39	2355	3 15 0	

The machines to which we awarded the prizes in this class not only produced the best samples, especially of finely-broken cake, but were also the lowest in price, and very strongly constructed.

TURNIP CUTTERS. *Trial with Mangold* (1 *cwt.*) *For Sheep.*

Name of Maker.	Article.	Time.	Revolutions.	Power (in foot lbs.).	Price.	Remarks.
		′ ″			£. s. d.	
Carson and Toone ..	526	2 5	64	..	4 10 0	
R. and R. Hunt	660	1 40	59	6440	4 5 0	
S. Corbett and Son ..	999	2 2	63	3950	4 10 0	
Edward Hammond Bentall	1500	2 19	71	5920	4 5 0	
T. and E. Howell ..	1091	2 17	74	4640	4 15 0	
Woods and Cocksedge	2290	2 45	86	6025	5 5 0	

Trial with Double Action, for Beasts and Sheep (1 *cwt. of Mangold*).

Name of Maker.	Article.	Time.	Revolutions.	Power (in foot lbs.)	Price.	Remarks.
		′ ″			£. s. d.	
Ransomes and Sims (Beasts)	3600	1 48	56	2570	5 5 0	£5
Ransomes and Sims (Sheep)	..	2 10	67	6510	..	
Edward Hammond Bentall (Beasts) ..	1502	2 17	74	4640	5 5 0	Commended.
Edward Hammond Bentall (Sheep) ..	..	2 52	89	5215	..	
Richard Hornsby and Sons (Beasts)	1589	1 40	52	4950	5 0 0	Prize £10
Richard Hornsby and Sons (Sheep)	..	2 11	68	6205	..	

Hornsby's disc turnip cutter we thought clearly in advance of any other in scientific construction. It possesses one great advantage in having the angle-knives (similar to Gardiner's) fixed on a bar which is so curved that the knives in cutting the roots tend to draw them to the centre of the disc; the peculiar form of the hopper also much helps to conduct the roots to the cutting surfaces. The roots do not "roll" in the hopper as in barrel turnip cutters, but fall uninterruptedly to the knives. In every other machine they required more or less hand-pressure to keep them in contact.

Root Pulpers.

Amongst the rough notes made during the trials opposite Hornsby's pulper (1592) this remark is written, "Hopper does the work of other peoples' hands;" inasmuch as the roots fell continuously to the knives, and none of that hand-pressing was necessary without which no other machine kept the roots in contact with them. In this pulper at the base of each knife is a clearance hole through which the pulped roots fall, and as the knives are so arranged that no two pass over the same track, the cutting action is very steady and regular. The simple provision of a patent horizontal oscillating bar, which receives its motion from an eccentric on the spindle, having teeth, through which the cutters pass, both prevents the escape of the last piece and clears the cutters. The pulper in appearance much resembles the same maker's turnip cutter, and possesses the same advantageous arrangement in hopper, frame, and disc. It is very strongly made, and produced an excellent sample of pulp. Two of the pulpers were driven with somewhat less power than Hornsby's, but the quality of the work and the construction of the implement were not so good. (See Table next page.)

Such are the facts in connection with these trials that we have to lay before the Society after giving to their relative merits our most patient and impartial consideration. We were anxious to conclude the trials earlier, but found that, after giving about twelve hours' attendance daily, it was impossible to do so, and at the same time insure an investigation that should be ample and convincing. More time seemed wanting in nearly every department, not that important work was hurried, or that decisions of high consequence were precipitated. On this ground, we strongly feel that the Society should either allow more time or provide a larger staff of implement judges;

that the public on entering the show-yard *on the first day* may be guided as they proceed to the implements that have won the prizes, and therefore may be presumed to be entitled to their special attention. The implement department grows with a steady and a wholesome growth. At the Oxford Meeting 20 exhibitors contended for 5*l.* and two medals. At Bury nearly 500 implements were catalogued, and 430*l.* besides ten silver medals were left to the disposal of the judges!

Trial with ½ cwt. Mangold.

Name of Maker.	Article.	Time.	Revolutions.	Power (in foot lbs.).	Price.	Remarks.
		′ ″			£. s. d.	
E. Hammond Bentall	1520	3 57	109	19,595	5 15 6	
R. Hornsby and Sons	1592	2 42	86	10,500	4 12 6	Prize £5
R. Hornsby and Sons	1591	2 30	77	11,520	4 12 6	
S. Corbett and Son ..	1001	4 24	133	16,625	4 10 0	
R. and R. Hunt	665	4 26	139	8,550	4 4 0	
Ralph Mellard and Co.	216	5 10	165	19,475	6 0 0	
E. Hammond Bentall	1510	2 56	91	9,125	4 4 0	Commended.
Woods and Cocksedge	2295	4 0	130	11,820	4 10 0	
Picksley, Sims, and Co.	2797	5 55	187	7,745	3 10 0	Commended.

Believing that it is essential to future and increased success and usefulness, and due alike to exhibitors and the public, that, after a fair and satisfactory trial has been instituted by competent judges, the best implements in each class should be pointed out on the first day of entrance into the show-yard, we respectfully commend the subject to the consideration of the Council.

We beg to tender our sincere thanks to the Stewards of Implements for the excellence of their arrangements.

EDWARD WORTLEY, } *Judges.*
HENRY CANTRELL, }

August 3rd, 1867.

Report of the Judges for Field Gates and Miscellaneous Articles.

Prize of 10*l. for best Gate:*

James Braggins (546), Strong Oak Gate with Patent Ironwork.

Commendations:

James D. Young (923), Iron Gate.
Frs. Morton and Co. (288), Iron Gate.
Bayliss, Jones, and Bayliss (1128), Iron Gate.
Saint Pancras Iron Company (1882), Iron Gate.

Of Field Gates entered for competion there was a great assortment, more especially of those made of iron, many of which we have commended; but as iron gates are considered to be less generally useful on the farm, the prize was awarded to a gate made of oak, very strong, simple in its construction, easily repaired (being fastened together with small bolts), with patent ironwork, which is merely a screw attached to the top of the gate, serving for a hinge, allowing the gate to be readily raised or lowered at the point.

Miscellaneous Articles.

Silver Medals were awarded to:

Woods and Cocksedge (2339), Strong One Horse-Power Gear.
Webb and Son, (3381 to 3396), Assortment of Leather Machine Bands.
Warner and Son (1229), Chain Pump for Liquid Manure.
Tangye, Brothers, and Holman (422), Four-Inch Double-Suction Pump.
Alfred Wrinch (3123 to 3201), Assortment of Garden Spring Chairs, and general collection.
A. B. Childs (4692), Patent Aspirator.
Boby, Clerk, and Co. (2951 to 2989), Assortment of Cast-Steel Draining Tools and Forks.
Burney and Co. (2737 to 2758), Strong Wrought-Iron Cattle Troughs and Cisterns.
Clayton and Shuttleworth (4735), Adjusting Blocks for fixing Engines and Threshing Machines.
Musgrave and Brothers (1367 to 1407), Collection of Stable and Cow Fittings, with Dog Kennel and Piggeries.

Commendations:

John Baker (56), Elastic Reaping Machine Rake.
Hawkes and Spencer (508), Patent Chain Corn-Drill.
James and Fred Howard (854), Double-Action Haymaker.
Richard Hornsby and Sons (1599), Improvement in Grass Mower.
Burgess and Key (324), Improvement in Grass Mower.
Wilkinson and Son (2724), Improved Horse Hoe.
Ransomes and Sims (3632), Iron Turn-Wrist Plough.
John Grant (3465 to 3468), Portable Railway and Turn-Table.
Ransomes and Sims (3656 to 3661), Improvement in Lawn Mowers.
Ransomes and Sims (3656 to 3661), Guard for preventing accidents from Drum on Threshing Machine.

The show of implements was a great increase on former years, 4804 being the number of articles exhibited, forming 282 stands. There was perhaps not so much novelty as on some former occasions, yet the *tout ensemble* was on the whole highly creditable.

The work of inspection was much impeded during the first two days, from many of the exhibitors failing to have their stands uncovered, and having no one to represent them.

The great variety of articles in the Miscellaneous Department rendered it advisable to keep in remembrance the Society's primary object, viz., "to encourage the manufacture of such implements only as are of practical use in agriculture." We were unanimous in deciding that the following articles were most deserving of notice:—

Woods and Cocksedge (2399). This Horse-Gear is made entirely of iron, a great advantage, as the lower frame is not liable to decay from exposure to weather and damp earth. The horse-wheel being extra large, lessens the draught; the intermediate motion is also of iron, fitted up with pulleys, and a short spindle is attached with a universal joint, which will allow of three machines being worked at the same time if required, of course according to the power wanted. This intermediate motion is fitted with a clutch to throw out of gear, which can be done instantly without stopping the horses.

Webb and Son (3381 to 3396). An assortment of Leather Bands, for driving machinery, of excellent quality, the leather being thoroughly strained and worked to a uniform thickness in its manufacture, thereby preventing the band stretching during use, a frequent cause of much hindrance and annoyance.

Warner and Sons (1229). A Chain Pump for Liquid Manure, of very simple construction, its peculiarity being that nothing can choke it. An endless chain with discs at definite intervals to fit the pipe passes over a wheel above, and entering the bottom of the pipe the liquid is elevated by the discs. The model shown had a barrel of about two inches in diameter, and into the water was thrown a quantity of stones and gravel; nothing seemed to interfere with its working, the stones and dirt passing out at the spout with the water; suitable for small depths, 12 to 15 feet; peculiarly valuable for manure, which destroys valves of ordinary pumps; simple, and not liable to get out of order.

Tangye, Brothers, and Holman (422). A Double-Action Pump in one barrel, with an air vessel of corresponding exterior, securing a continuous jet, and producing a powerful hydropult. It is worked by a central spindle, without either rods or guides, whereby the working parts are reduced to a minimum. A new arrangement of the valves allows of every part of the pump being examined without disconnecting any of the pipes.

Alfred Wrinch (3123 to 3201). An assortment of garden seats, tables, spring chairs, &c.; the whole collection being really meritorious, we were induced to deviate from the usual practice of confining the awards to what may be properly termed "Agricultural Implements."

A. B. Childs' Aspirator (4692). This machine is very simple and durable, and may be worked by either hand or steam power. Separation is effected by aspiration, without riddles, according to specific gravity; each grain is weighed as in the most delicate balance, and every ingredient lighter than the good grain is removed and separated. We had no opportunity of testing the power required, but it would doubtless be considerably greater than that required for ordinary winnowing machines, a defect which the inventor considers to be counterbalanced by the perfect way in which the grain is cleaned by one operation.

Boby, Clerk, and Co. (2951 to 2989), exhibited an assortment of draining tools, forks, &c. The draining tools consist of nine pieces, made of solid cast steel, and the forks of the same materials, combining lightness and durability.

Burney and Co. (2737 to 2758), a collection of strong Wrought-Iron Cattle-Troughs and Cisterns, made of the best Staffordshire iron. For their strength, lightness, and durability, they are highly meritorious; the price per gallon is very moderate, and deserves notice.

Clayton, Shuttleworth, and Co.'s "Adjusting Blocks for fixing Steam Engines and Threshing Machines" we considered worthy of a medal. It is a very simple and ingenious contrivance, by which an engine or threshing machine may be thoroughly fixed in half the usual time, without any chance of its slipping afterwards.

Musgrave and Brothers (1367 to 1407), a large assortment of stable fittings, cow stalls, &c. A speciman of a loose box, 12 feet square. The door folds back perfectly flat, and having no projection, removes all fear of a horse being injured. The fittings altogether may truly be termed harmless; the water-pot is fixed on pivots at the sides, by which means it may be emptied without removal from its place; the water passes underneath the floor of the box by a drain, covered with loose plates of perforated iron, any one of which can be easily removed in case of obstruction; the water-pot and manger are enamelled, and can be enclosed by a grating, which fastens back when the horse is feeding. The rack is furnished with a sliding hay-guard, which lies on the top of the hay, preventing any undue waste. One special improvement to be noticed is the "noiseless tie;" by merely a touch of the finger the horse may be released at once in case of fastness. A sliding bar is inserted in the divisional partitions, and this can be pulled out on leaving the horse for the night, so that

in case it should get loose it would be confined to the space opposite its own stall. The whole arrangement is admirable, giving health, comfort, and safety to the animal. The piggeries, cow-stalls, and dog-kennels are equally well adapted to secure comfort and cleanliness.

John Baker (56). An Elastic Reaping-Machine Rake (commended). This rake is provided with elastic spring teeth, attached to independent parts or sections, similar in principle to the Haymaking Machine, so that, when meeting with extra resistance, the teeth will yield to the strain, and will instantly resume their proper position again when the obstruction is passed; hence all chance of breakage in the teeth of the rake and other parts connected is greatly diminished.

Hawkes and Spencer (508), a Chain Corn Drill; rather a novel contrivance for ensuring a regular deposit of corn. The advantages which it presents are that the deposit is regular, whether it works up hill or down; that the speed of the horses does not interfere with the quantity sown; that only one wheel has to be changed, whether the seed be five pecks or twenty-five pecks to the acre; the "feed" being regulated by means of a lever and "index" attached to the end of the corn-box.

James and Frederick Howard (854), a Double-Action Haymaker. Its chief advantage is, that the axle-boxes revolve, the barrel being on the main axle; the forks are always the same distance from the ground, and the machine will cross ridge and furrow. The principal cause of breakages in old-fashioned haymakers was that the barrels and travelling-wheels did not rise and fall together. The side frames are outside the travelling wheels, so that the grass does not lodge; there is simplicity of gearing by the barrels sliding out; the whole is readily got at.

Richard Hornsby and Son's Paragon Reaper (1599) varies from most other machines, by having a direct action to the knife, the cutter-bar being jointed directly to the crank shaft. The draught also is taken from below the pole, and from the front of the frame, a little to the cutting side, obviating the objectionable side draught, and weight on the horse's neck. Here also was exhibited a Reaper, termed "Governor Self-Reaper," on similar principles. It is so called because the rakes are worked on a principle similar to the governors of a steam-engine. These rakes are carried by a vertical axis, and brought low enough on the cutting side by a cranked carrying-bar to gather and deliver it into sheaf at the side, leaving a broader clearance than is usual. The position of the rake being much forwarder than common, gives an advantage in the gathering of crops, particularly when laid.

Wilkinson and Son's Horse Hoe on improved principles (2724). Each hoe works on a separate lever, and is kept at a uniform depth by means of a regulating wheel in front of each hoe, so that however uneven the surface of the ground the weeds are effectually destroyed. The hoes can be given more or less pitch, according to the state of the land; the steerage affords a ready means of keeping the hoes in their proper position between the rows of corn; the cutting blades are made of steel, and easily replaced when required.

Burgess and Key's Mowing Machine (324) has been greatly improved in its construction since the Plymouth Meeting. The credit of introducing the short connecting-rod and direct thrust to the knife belongs to this firm, who exhibited it at Plymouth.

Ransomes and Sims (3632) showed a New Iron Turn-Wrist Plough, with steel breasts, of their usual excellence in manufacture. The mechanism by which first one, and then the other mould-board is brought into work, whilst at the same time the wing of the share is reversed, is very simple and effective. The coulter and wheels are also so arranged that their position may be changed from side to side without the ploughman having to leave the handles. The Automaton Lawn Mowers also exhibited at this stand are very simple

and light in draught; the improvement in the driving gear is dispensing with the old ratchet and levers, and therefore with the noise occasioned by the clicking of the ratchet-teeth, whilst as the name Automaton signifies, the machine is self-regulating, being always in gear for the forward motion, and out of gear when drawn backwards. They have also made a very laudable attempt in constructing a guard to prevent accidents with thrashing machines; it is made of wood, in the shape of a large hopper, placed over the mouth of the drum; and on the front of the hopper a hinged grating is attached, which when down completely shuts off the drum. Anything by which accidents with machinery can be avoided is highly valuable; and this we consider most commendable.

Richmond and Chandler exhibited a straw cutter with this improvement; inserted at the bottom of the feed-box is an endless lath and chain propeller, carrying forward the straw, clover, &c., giving great assistance to the "feeder," especially in case of short materials being used. Two bevel pinions keyed on to the fly-wheel shaft, gearing into two bevel wheels of unequal diameter, with one handle, enables the machine to cut two lengths, and provides an instantaneous stop-motion. No extra shafting or pedestal is needed beyond what is required in all other machines cutting one length.

Owens and Co. exhibited the "Cassiobury Fire Extinguisher," a simple and portable fire-engine. The great advantage is that it can be immediately brought to bear, and a man or woman may stand at any distance from 10 to 50 feet from the seat of fire, according to circumstances, and deliver a strong jet directly upon it. It will deliver a good volume of water 35 feet high, and 50 feet horizontally; it is not liable to get out of order, and occupies but little space.

Woods and Cocksedge's arrangement for piggeries is very simple and efficient, the feeding troughs being in front, hanging on a pivot, accommodating either large or small pigs, according to the angle at which it is placed.

Under the head of articles not usually classed with Agricultural Implements, there were a great number of very useful things for ordinary purposes, which it would be impossible to enumerate in this report, but we may mention that Mr. Windover's carriages, made of Hickory and Steel, seemed to combine in a high degree lightness, elegance, and durability. Amongst the novelties we may also mention "Hancock's Spring Bed," and the "Gurney Beach-Seat," as being worthy of commendation.

JOHN THOMPSON.
JOHN WHEATLEY.

With such an entry the duty of the two gentlemen who have so ably reported was no sinecure. The very fact of having to examine nearly 5000 articles implies severe labour, even if there were no hindrances. Exhibitors, supposing they receive due notice as to the day and hour when the judges will inspect, should be at their stands to explain novelties or ingenious inventions which they consider worthy of notice, whereas they were continually running after the judges, and perplexing and hindering them not a little. Some of the makers never came in contact with the judges at all, and many were the eager inquiries addressed to any man wearing a badge, to know if he was a miscellaneous judge.

We proceed to notice some of the novelties. From time to

time attempts have been made to invent a good drying machine for corn, which would prove a great boon, after such a harvest as that of last year; hitherto these attempts have failed, chiefly on the score of costliness or the impracticability of the various schemes. James Paxman's invention, exhibited by Davey, Paxman, and Davey, of Colchester, is a step in the right direction, inasmuch as the drying apparatus is combined with, and a part of an ordinary portable engine and thrashing machine, so that damp corn may be thrashed and dried at one operation; after being thrashed and once winnowed the corn is passed into a cylinder, surrounded by a steam jacket. The corn during its passage through this cylinder is subjected to a double action, namely that of the steam in the jacket and of a blast of hot dry air generated in a small furnace on the opposite side of the machine, and sucked up and circulated by a fan; this current meets and completely passes through the corn as it is travelling along the cylinder. The steam is conveyed through a ½ in. opening in the boiler by vulcanized tubing to the cylinder, the waste steam partially condensed is collected at the other end and is used to warm the water, and thus save fuel. The corn remains exposed to this double agency for about 1½ minutes, that being the interval consumed in passing through the tube. The wheat experimented on was first damped with 1 gallon of water to the bushel, and was in a soft and very bad condition, more lumpy than it would be after the worst harvest; it came out quite hot and in a sweat, it should then be laid on a floor and turned, when it soon cools and hardens. The exhibitor, over confident of his machine, told the judges that the corn might be left in a sack, so it was left, heated a good deal, and came out clammy and "nosey." This was not a fair test, as there must be time for the moisture which is drawn out of the corn to escape. Mr. James Amos made a rough experiment to ascertain the loss of steam taken from the boiler, by ascertaining the degree of heat communicated by the waste steam to a given quantity of cold water during a fixed interval. As far as could be judged the loss was about ¾ of a horse power. All barley growers well know what a mess they are in with their crops after a wet cold season, how unkind the corn, how difficult to sell to the maltsters save under a guarantee. In such cases an expensive process of sweating is necessary before germination can take place, and it is a question of much importance how far this drying arrangement could be made use of in place of the kiln. It would be necessary to exercise great caution as to the temperature, since too sudden or great a heat would destroy the germinating powers of the corn. The idea is ingenious, the

apparatus simple and inexpensive, and we think that something may be made of this novel application.

Mr. William Creasy, of Bull's Hall, Bedfield, Wickham Market, exhibits another drying and cleaning machine. The object being to pass heated air through a uniform thickness of grain, whilst the latter is being gently agitated to dry it quickly at a moderate temperature; this is particularly important in the case of barley. The machine consists of an inner and outer cylinder, covered with perforated material such as zinc or iron. The inner one is fixed to a hollow tube which runs through it, this tube is supported at each end by stands. The outer cylinder revolves on this fixed tube by the aid of friction rollers, leaving a space between the two cylinders at the sides and ends of from 6 to 9 inches. The corn is fed into this space by a pipe which runs from the outside hopper through the tube (which carries the cylinder) in a diagonal direction, dropping the grain between the ends of the cylinder, it is then carried round by the outer one so as to fill up the space between them; the corn being regulated at the discharge end, the space is kept constantly full. The corn is gradually drawn along from one end of the machine to the other by blades which project from the outer cylinder in an angular direction. The discharge is arranged in a similar manner to the feed, viz.—by running a pipe through the tube in a diagonal direction from the inside to the outside of the machine. The heat is thus produced, the fire is contained in an inner vertical cylinder, surrounded by an outer cylinder, leaving an annular space between them of 5 or 6 inches, a passage is made from the outer to the inner cylinder through this space to supply fuel. The outer cylinder is connected with a fan on one side, and with the tube which runs through the machine at the other. The radiate heat in the outer chamber greatly assists the process. The heated air is forced through the perforations of the tube into the inner cylinder, and so through the corn which surrounds it into the air, carrying with it the moisture arising therefrom. The temperature of the heated air is regulated by a valve opening in the lower part of the cylinder containing the fire through which a small portion of the blast can be directed, and the heat rendered more or less intense.

In the second machine exhibited for drying malt, brewer's grains, &c., the cylinders are covered with sheet iron, and are both made to revolve in one direction by gear work, though at slightly different speeds, fitted with hollow perforated blades which agitate the material to be dried, and also allow the hot air to circulate. The corn machine is said to be capable of drying 70 or 80 bushels of corn daily at a temperature varying from

90° to 100°, and with an expenditure of about 3-horse-power. This is certainly a meritorious invention deserving of notice.

Messrs. Howard's Safety Steam Boiler and superheater consists of a series of vertical tubes, amongst which the fire circulates with great facility; it is introduced in place of the ordinary Cornish boiler for fixed engines, and appears to possess some considerable advantages; each tube has within it an internal one rising up through the water space, dividing the water into annular and central columns; the current of heated air impinging upon the tubes, causes the water in the outer spaces to rise to the top and flow down the inner tubes; an active circulation through all parts of the boiler consequently results, and even hard water leaves no incrustation. The points of merit contended for by the makers are—*Safety*, the bursting pressure of each tube being calculated to be 2000 lbs. per square inch, and if, notwithstanding, a tube burst no dangerous accident could follow: *Economy of fuel*—In a 40-horse boiler steam is raised to 80 lbs. pressure in 20 minutes with 2 cwt. of coal. We have not seen these results, and merely state them as given by the exhibitors. There is economy in using superheated steam, the steam space or reservoir being exposed to the radiated heat of the heating chamber. The different parts are well put together and simple, no bolts or joints are exposed to the action of the fire. One of these boilers is being employed to drive machinery at the Paris Exhibition.

One of the most attractive features of the Miscellaneous exhibition was Eli W. Blakes stone breaker and ore-crushing machine, exhibited by H. K. Marsden, of Soho Foundry, Leeds. This invention has the merit of simplicity and efficiency, being capable of smashing up granite and swallowing large sized stones. A vertically suspended jaw, with an indented or furrowed surface, is made to play backwards and forwards, coming in contact with a similar fixed surface. The opening being widest at the top and contracting downwards, large masses are converted into small fragments by a series of crunches, as they descend. The motion is acquired by means of an elbow joint leverage, working from an eccentric on the fly-wheel shaft; driven by a 3-horse engine, it is capable of reducing 40 tons of metal per day. A rotating screen working below receives the crushed material, and separates it into two samples. With jaws 10 in. by 7, the price is 140*l.* The uses to which this ingenious contrivance is adapted are many. The ironmasters in North Lancashire and elsewhere employ it for breaking up slag for road-making at a cost, it is said, of 3*d.* a ton. It is used for making concrete and asphalting, and for reducing ordinary

road metal it must effect a saving, provided there is sufficient work to do. Cameron's steam-pump, exhibited by Tangye, Brothers, and Holman, London, alluded to in the judges report, is an exceedingly ingenious invention. We venture to extract a short description from *Engineering*, which publication contains a better account than we could give. "This is the simplest of the class of pumps with steam moved valves which has come under our notice, at each stroke the steam-piston knocks open a small piston valve which admits steam to a large piston, one on each end of the slide valve, and which work the latter by direct action of steam. These pistons (to the valve) have no packing, and are the simplest possible. They cushion perfectly. A handle on the outside puts on the slide valve at starting, in case it is not well over to admit steam. The best test of steam-pumps of this class is to see, not how fast, but how slow they will go, and we worked Cameron's so as to make but a single stroke per minute, the stroke being but a few inches in length. At these very slow speeds the stroke is not gradual but intermittent, the engine stopping to collect steam at the end of the stroke. The action is certain at all speeds, and when working at full speed and with 100 lbs. pressure in the air vessel, the suction hose may be suddenly lifted out of the water without the pistons striking the ends of the cylinder covers. The parts are so accessible, that although still hot with steam, we had it to pieces in hardly more than a minute." We have only to add to the above excellent description that the price of this pump is 30*l.*

C. Burrell's machine for shelling and dressing clover and trefoil seed, with patent separator for removing weed seeds, appears a valuable invention; by submitting the seed to a double operation, the shells are completely removed, and the seed is not broken. 25 sacks of clean seed can be thrashed in a day. Price, 60*l.*

Gooday's multiple needle thatching machine, is an improvement on Magg's and Hindley's invention. The straw being carefully drawn and laid on a table is passed between rollers and fastened together by a lock-stitch. The price is moderate, and provided the work can be done with sufficient celerity, this promises to be a useful addition to our agricultural novelties.

XXII.—*Report on the Exhibition of Live Stock at Bury St. Edmund's.* By C. Randell, Senior Steward.

When in the early part of 1866 the Council of the Royal Agricultural Society reluctantly came to the conclusion that the increasing ravages of the Cattle Plague rendered it expedient to suspend for a year the show at Bury St. Edmund's, they were influenced not alone by the apparent certainty that a show from which cattle would necessarily be excluded must be a failure in reference to the immediate interests of the Society, but also by the conviction that a meeting so deprived of one of its greatest attractions would prove a disappointment to the inhabitants of the town and district where such meeting should be held. It was therefore resolved, with the concurrence of the Local Committee, that a year should elapse, in the hope that the plague might then be stayed, and a Cattle Show be held in 1867. The liberality and energy which the inhabitants of the town and district had already shown through their Local Committee, and their readiness to meet every wish of the Council as to the preparation of the showyard and the approaches to it, materially influenced the Council in their decision to wait a year, in order that a successful meeting might compensate the district for the exertions which the inhabitants were ready to make to ensure that success.

But the plague remained, and the Council felt that although they had by the appointment of a Commission to inquire into and report upon the results of steam-cultivation, done the greatest good in their power to the general interest of agriculture in 1866, yet that a show must be held in 1867. It has been held, and although, as was anticipated, the result to the Society in a pecuniary sense is a failure, it is satisfactory to record that the exertions of the Local Committee continued unabated to the last—that the show of horses was partially successful—of implements, sheep, and pigs entirely so, and that the agricultural population of Suffolk and the adjoining counties evinced the most lively interest in the contents of the showyard, and the exhibition of steam-cultivation outside of it.

It had been a primary object of the Council to make the show of Horses at Bury St. Edmund's compensate as far as possible for the absence of cattle, and very liberal prizes were offered; the result was a larger entry than at any previous show, Battersea excepted, still not so large as the Council had a right to expect, and the deficiency was noticeable in the horses of the district, which in some classes have often been more numerous at the local shows—it may be that those local shows having been

held previously, were the means of pointing out to owners that their chances of success at Bury were gone, and the excellence of those animals which were exhibited, pretty clearly showed that only the best had been thought good enough to put in an appearance. Still the fact remains, the show of Horses has not yet been as good as it ought to be. In cattle, sheep, pigs, and implements, the Royal Society's shows have been pre-eminent, and, although in the estimation of practical farmers generally all these stand higher than hackney-horses, yet in this department, as in all others, the same pre-eminence should be attained; and by liberal prizes, and the most liberal accommodation, the difficulty which will often arise from the distance at which the meetings are held from the principal horse-breeding districts, must be counteracted.

In Class I., the prizes of 100*l.* and 50*l.* attracted 6 thoroughbred sires; and the well-known "Scottish Chief" could only get second to "False Alarm," the winner at Islington; it must have been a nice point for the judges to decide whether the comparatively short legs and long ribs of the "Chief" should outweigh the beautiful action of the "Son of Trumpeter," but the latter won, as it has often done. In Classs III., the hunting brood-mares mustered strongly, the grand old "Silverlock," belonging to Captain Barlow, being placed first; a thoroughly useful looking brown of Mr. Hurrell's, second; and a stylish mare, not equal to so much weight, Mr. Harvey's, third. In Class LXIII., for weight-carrying hunters, 5-year old and upwards, 17 competed, and formed the most attractive class that has been seen in the Royal Society's showyard, a grand lot of what they professed to be—weight-carrying hunters, from which the judges selected the "Master of Arts," Mr. Gee's, for the first prize, a very grand horse to look at. Mr. Sutton's "Voyageur," the horse for an old gentleman to enjoy hunting upon, was second; and Mr. Heygate's "Mountain Dew" the third, looking likely to keep his place with either in a fast twenty minutes; exclusive of these many a 14-stone man would like to be allowed to make his selection, and go away content with Mr. Hall's "Double First," Mr. Taylor's "Harkaway," Mr. Wilson's "Sir Harry," Mr. Pretty's "Baron," or Mr. Williams's "Charlie" and still leave other real hunters.*

* The Report of the Judges, Messrs Thurnall, Smith, and Oldacre, just received, (Sept. 14,) contains the following remarks:—

Class I. *For the Thoroughhred Stud Horse best calculated to improve and perpetuate the breed of sound and stout Thoroughbred Horses for General Stud Purposes.*—The contest was a close one between the first and second horse, and had the question been simply which was the better sire for getting racehorses, their places might have been reversed; but we considered 'False Alarm' better adapted for

For the first time at a show of the Royal Society a leaping-bar was placed in the ring, and formed a great source of attraction, when the hunters above 3-years old displayed their jumping powers, they were not required to do so by way of influencing the Judges at arriving at their decision, seeing that many first-rate hunters object to this kind of "larking," but it certainly amused the public and did no harm; on the contrary, more than one of the horses improved in temper by the proceeding, and went home with a better promise of making a hunter than when he came to Bury.

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the general purposes which the Society has in view: his action was truer, he had the best feet, and carried himself best—moreover he was giving his opponent a year. The 'Chief,' on the other hand, had a better loin and somewhat more length.

Class II.—*Stallions for getting Hunters.*—The seven entered may be divided into two classes—one having plenty of breeding but little substance, the other plenty of substance but a deficiency in quality. We felt it our duty, although very reluctantly, to pass this class over without awarding a prize.

Class III. *Mares suitable for breeding Hunters.*—The competitors in this very important class were more numerous than usual, and there were several very good ones to select from. The winner, 'Silverlock,' was a lengthy low mare, looking as if she had been a hunter herself, and just the right stamp to breed more. The second, a mare by 'Theon,' was very powerful, had great length, and a rare set of legs; she looked all over a hunter, but her foal was leggy and did her no credit. The third was a very game-looking mare, full of quality, but not quite equal in power to the other two. Added to these was a thoroughbred chesnut mare of Major Wilson, which would have stood high in the class had not the veterinary inspector disqualified her.

Class LXIII. *Weight-carrying Hunters.*—Here we had an entry of seventeen, including several well-known prizetakers, viz., 'Master of Arts,' 'Voyageur,' 'Mountain Dew,' and 'Buffoon.' 'Voyageur,' when standing, is a very fine specimen of a hunter; but his action, though true, lacks force and energy. 'Master of Arts,' is very powerful and gallops strongly; but he bores, and wants pulling together and better handling than he had here. 'Mountain Dew,' the third in this class, is a fine slashing goer and looks all over a hunter, as did also the reserved number, 'Harkaway,' and the commended 'Buffoon.' 'Double First' is a nice active horse, but not equal to the same weight as those before mentioned.

Class LXIV. *Four-year old Hunters.*—In this class of fifteen were the well-known 'Tom' and the 'General,' and 'Denmark,' from Herefordshire, who took the second prize, and thus parted the stable companions. 'Tom' is a horse of wonderful power and length; his legs and feet are excellent, his arms and thighs wonderfully muscular; he is a grand goer, and perhaps, take him all in all, one of the best four-year olds ever shown. 'Denmark' is own brother to 'Mountain Dew,' and, like him, a fine goer; he is a little higher on the leg than 'Tom,' and not equal to the same weight, but he promises to be a first-class hunter. The 'General' is a very elegant horse, nearly, if not quite, thoroughbred, a beautiful galloper, and carries himself in fine form; and we have much pleasure in reporting that we have seldom seen three such young horses together. A nice chesnut of Mr. Clark, of Hook, was the reserved number, and a raw grey of Mr. Jacob Wilson's looked like making a hunter.

Class LXV. This was a poor class of only five, and, owing to what appeared to us an unnecessary requirement for three-year olds, one of the best of this small class was disqualified, on the ground that being unbroken she could not be ridden in the ring; and the result was that we felt it necessary to abstain from awarding a prize.

It is very satisfactory to me that the Judges of other riding-horses—the Hon. George Lascelles, Mr. C. Nainby, and Mr. Beevor have left nothing for me to say; they report,—

We commenced our duties under very unfavourable circumstances as to weather, with Class IV. (Roadster Stallions), which, as might be expected in the native country of trotters, was well filled; and we consider No. 42, Mr. Beart's "Ambition," an excellent specimen of the class, having extraordinary action. Mr. Grout's "Sportsman" No. 40, was a useful, compact, active horse, an excellent mover, and of true and level form. Mr. Grout also showed a horse with wonderful pace and action in his trot, in No. 47, but rather narrow, and not a good walker.

Class V. was not well represented, and there was nothing in it of extra quality. Mr. Overman's "Jenny Lind," a true-shaped useful mare, likely to breed well, and with a promising foal, took the first prize; and Mr. Reddell was second with "Bury Belle."

Class VI. had only one representative in the ring, and as he was a useful pony, we gave him the prize.

Class VII.—We do not consider this as a good class, and the prize horses could not aspire to be more than useful hacks.

Class VIII. had but one entry.

Class IX. was good, and the first prize pony shown by Mr. Wallis is full of action and quality, and no doubt will some day attract some attention in Rotten Row. Captain Barlow's black "Piccadilly" is also a good pony with action, and Mr. Branthwaite's pony well worthy of a prize. Our reserve number: Mr. Groucock's "Puss," a compact neat cob, with short quick action.

We then proceeded to award the Local Prizes in our department, and commenced with Class LXVI. for Hacks, 5 years and over, not less than 14, and not over 15 hands. In this class we had some difficulty, owing to the appearance in the same class of horses of a totally different character, and we would suggest that it is advisable to class hacks according to the weight they are intended to carry. Though there might have been hacks up to more weight than the prize horses, yet the excellent action of No. 218 and No. 215 led us to place them first and second; and we feel sure that Mr. Badham's "Major" is both an easy and showy conveyance over the "McAdam." Mr. Harvey's "Favourite" showed full of Arab blood and action, which made it impossible for us to pass him over, though perhaps more of a charger than a roadster.

Class LXVII. did not long occupy us, as only a couple presented themselves in the ring, and Mr. Scriven's "Lotte," a compact old-fashioned nag with action took easily the first prize.

Class LXVIII. was inferior, and the prize-takers, No. 236 and No. 235, were not of extraordinary merit.

Class LXIX. had no entry.

Class LXX. we could not report as a good class.

Class LXXI. was altogether a good one, and contained several clever ponies. We hear that this is not the first time by any means that Mr. Milward's "Steward" has caught the eye of Judges by beauty in form and action. Mr. Milward also got the second prize with his "Dunbar," a clever pony with famous action, but a trifle heavy about his neck. We commended No. 251 and No. 255, both useful horses.

Class LXXII. was limited in number; but there was nothing came before us more perfect than Mr. Wade's "Tomtit," full of quality, action, and a tower of strength. Mr. Ritter's "Tommy" was a little beauty, with a wonderful forehand and sweet head. This class brought our labours to an end, and allowed us at last to seek shelter from the rain which had descended heavily

all the day. We would venture to suggest that the full particulars of each class should be entered in the Judges' books, and so avoid the necessity of constant reference to the printed prize sheet, which, in a soaking rain, is attended with some difficulty.

G. E. LASCELLES, }
C. M. NAINBY, } Judges.

In agricultural horses, the Suffolks, as was to be expected at Bury St. Edmund's, made a very attractive display, although in point of numbers some classes were deficient. Class X., for old stallions, had only 5 entries, of these Mr. Boby's "Conqueror," grand to look at, was first; Mr. Crisp's "Duke," younger, more level, with more action, second. The 2-year olds in Class XI. mustered more strongly, and far a-head among them is the first prize colt, Mr. Wilson's "President;" Mr. Crisp with a very good one is second; and Mr. Clayden's executors, third, with a neat but small one; two others, Mr. Grant's and Mr. Biddell's were highly commended.

If the Suffolk breeders did not show us many of their grand old mares, certainly those they did send were good ones. Of the 7 entries Mr. Wolton's "Moggy" is a wonderful mare, his "Violet." the second to her, a great beauty; Mr. Tomline's "Danby" good enough to obtain a first instead of third prize anywhere but here; and Mr. Sewell's "Bragg," a great, good mare, not placed. Short in number as this class was, it did great credit to the county. In Class XIII., for 3-year old mares, there were only 4 competitors, one of these, belonging to Sir Edward Kerrison, was objected to as not being pure Suffolk; no evidence was adduced in support of the objection, and if there be anything in it, other Suffolk breeders will be trying to get into the same cross, for assuredly a more perfect animal is seldom seen, she obtained the first prize; the second going to a low, level, useful mare shown by Mr. King. Class XIV. had only 7 2-year old fillies, about a third of the number we have sometimes had, but again admirably selected, Mr. Cross obtaining first prize with a very fine mare. For the Special Prizes offered by the Local Committee of Bury St. Edmund's for 3-year old Suffolk stallions 4 were shown, Mr. Crisp's "Cup-bearer" first; Mr. Biddell, with a real "Punch," second. For the pairs of mares only two appeared, Sir Edward Kerrison winning with very good ones, one a 3-year old, an extraordinary mare. For mares not having had a foal in 1867, 5 very good ones were shown, Mr. Keer first; Sir Edward Kerrison, second; and the Marquis of Bristol, with two good mares got a high commendation. Only one pair of geldings were shown in Class LIX., the Duke of Grafton's. Fourteen were shown in the class for yearling entire colts, and the Judges commended the whole lot, although among them one

black-brown, and one bay colt, the latter a very good one, seemed out of place: Mr. Wolton had first prize with a very superior colt; the second went to a very light boned one, shown by Mr. Tomline; and the Suffolks finished with 5 nice yearling fillies, the two best of which were shown by Mr. Rist; Mr. Wolton was highly commended, and the two others were commended.

The classes for agricultural horses, not Suffolk, were not well filled, nor was the quality of those exhibited very good, if we except Mr. Coy's 4-year old "Matchless;" Mr. Welcher's white-faced 2-year old, and Mr. Holland's old mare, a winner when two years old at the Royal Carlisle Meeting.

The Judges of these classes say of the Suffolks:—

Nearly all the animals exhibited had good symmetry, action, and constitution; in some cases these points have been obtained with the loss of size and substance required for farm-work.

The Agricultural Horses not Suffolk were shorter in numbers, but most of them have good action, symmetry, and size. The Judges consider it part of their duty to report a special improvement in the Classes of Young Horses, scarcely any of those imperfections appearing amongst them likely to become hereditary, which have so frequently been complained of at previous shows.

The great number of the classes of horses, and the necessity for keeping all entire ones in the range of boxes specially erected for them, prevented the classes following consecutively the order of the catalogue, and so caused occasional difficulty to the visitors in finding any class they wanted; this has not escaped the notice of the Hon. Director, and it will doubtless henceforth be removed.

SHEEP.

Leicesters.—The Judges, Mr. Buckley, Mr. Clarke, and Mr. Mann say:—

We found Class XX., although numerous, far under an average.

Class XXI.—The older sheep far above the average of late years.

Class XXII. (Shearling Ewes).—Nothing to remark upon.

Still these gentlemen found among the shearlings three prize animals—one deserving a high commendation, and three others to commend, so the class must at least be considered respectable; while the old rams, 21 in number, headed by young Turner's wonderful three shear, closely followed by Mr. Burton's second and third prize sheep, were all commended. Of the 4 entries for shearling-ewes two got prizes—one was highly commended, and one commended; these facts put together prove that the show of Leicesters at Bury was a good one.

Cotswolds and Lincolns.—The Judges, Mr. Bartholomew, Mr. Little, and Mr. Newton, report:—

The COTSWOLDS were not well represented from their native district, either in point of number or quality.

The Norfolk breeders were in great force, and gave the Cotswold breeders notice to take care of their laurels, as all the prize sheep were bred in Norfolk.

The first prize Shearling of Mr. Brown of Marham, Norfolk, was a very

superior specimen of the class, being of large size, with excellent quality of wool and mutton. The second prize sheep, belonging to the same gentleman, was very little behind. The third prize sheep, belonging to Mr. Aylmer, was a strong, useful, large sheep, not of the same quality as the former; but with an excellent fleece of wool.

The Shearlings from the original Cotswold breeders were not up to the standard of excellence usually exhibited at the Royal.

The Aged Rams were a good class, so much so, that the Judges commended them generally; and Mr. Brown and Mr. Aylmer were as successful as in the Shearlings, showing very good specimens, the former taking the first and second prizes, and the latter the third.

The Shearling Ewes were not numerous, there being only 7 pens. Mr. Brown was again successful, showing a pen of fine symmetry and quality, seldom has a better been exhibited; Mr. Aylmer being second and third again, with 2 pens of very good ewes.

THE LINCOLNS AND OTHER LONG WOOLLED SHEEP.—This class was by no means largely represented, there being only 33 entries: 17 Shearlings and 11 Aged Rams, 5 pens of Shearling Ewes, two of which were disqualified.

The Shearling Rams: Mr. Aylmer took first prize for a Lincoln, apparently with a dash of the Cotswold. Mr. Marshall's second prize sheep had the true character of a Lincoln, having a good fleece of wool and fair quality. The sheep in this class were not well represented.

In the Aged Sheep, Mr. Wright of Nocton, in Lincolnshire, showed a very superior sheep, and obtained first prize. Mr. Charles Williams, of Carlton-le-Moorland, gained the second prize with a good sheep; the class was superior to the Shearlings, having good wool and mutton.

The Shearling Ewes did not possess any particular merit, only 3 pens were left to compete for the prizes.

Oxfordshire Downs and Shropshires.—The Judges, Mr. Masfen, Mr. Hobbs, and Mr. Edmonds, say of the former:—

Class XXIX., comprising 13 Shearling Rams of ordinary merit, we may dismiss with the remark that, although there are some large-framed fat-natured sheep exhibited, we do not think them so uniform in their character or so muscular as they should be.

Class XXX., for Aged Rams, brought together three competitors only, the first and second prize sheep, both belonging to Mr. Wallis, being two useful animals, with great propensity to fatten, and of full average merit.

In Class XXXI. there were six entries of Shearling Ewes of rather different type, the first and second prizes being awarded to Mr. C. Howard for sheep of good character and symmetry, though not so heavy or in such high condition as Mr. Overman's third prize pen.

Of the Shropshires the same gentlemen report:—

We were highly gratified to find the classes so largely and well filled with animals, whose general appearance gave unmistakeable proofs of careful breeding, and of their distinctness as a race; the sheep exhibited at this meeting were for the most part of uniform character, good colour, excellent symmetry and size, and combining with these properties the essential requisite of being rent-paying and profitable in the quantity and quality of their wool and mutton.

Class XXXV. was well supported by 39 Shearling Rams. The prize and commended sheep, shown by Messrs. Evans, Mansell, Crane, Smith, and Bowen, are decidedly good and handsome; and several others, not specially referred to in our remarks, are creditable representatives of the breed.

Class XXXVI. consisted of 13 Aged Rams, including some of more than average merit. The first prize sheep, belonging to Messrs. Crane, is very handsome, of masculine character, yet symmetrical and of fine quality; he is well supported by Mr. Mansell's second prize sheep, which is also of good character

with a heavy frame on short legs. The third prize ram (Mr. Evans's) is an animal of good size, but, although well fed, is a little slack in points.

Class XXXVII. contains a full average entry of Ewes, amongst which are some very good animals; but we do not think the class so uniformly perfect as those of the males. Mr. Smith's first prize winners consist of four ewes of perfect symmetry and fine quality, and one with a capital body, but rather weak neck. The second prize sheep (Mr. Horton's) are heavily fleshed, and of good size, but not so high in quality as their victors. We consider some of the other sheep in this class may be improved by a stricter attention to uniformity of character.

No doubt this is so, but a comparison of the Shropshire sheep shown at Bury with those at any previous Royal meeting will show that an approach to uniformity of character has gradually but decidedly been obtained, and considering that in the process of improving the old spotted-faced Shropshires the breeders have been by no means agreed as to the type which it was most desirable to establish, it is not surprisiug that some variation of character still exists, or rather it is remarkable that among so large a number of exhibitors the specimens of their different flocks should show so few exceptions to uniformity of character. Certain it is that the Shropshires are fast making their way into new localities, and that no flockmasters in the kingdom appear to be more unsparing in their efforts to excel each other, whether in breeding, feeding, *or shearing*, than the men of Shropshire.

The Southdowns as usual formed the most striking feature of the sheep show—perfect in form and quality of flesh, and so nearly alike in character, one only regrets that their want of size must confine them mainly to their native downs, and that the occupiers of deeper stronger soils must be content with less neatness and less quality in order to obtain greater rent-paying qualities. The Judges, Messrs. Fookes, Turner, and Budd, say:—

The Class of Shearling Southdown Rams was, with few exceptions, very good; especially those exhibited by Lord Walsingham and Sir W. Throckmorton.

The Class of Rams of any Age was considered by the Judges to be one of the best ever exhibited at the Meeting of the Royal Agricultural Society, and was generally commended.

The Shearling Ewes were very good, with the exception of a few pens. The pens exhibited by Sir W. Throckmorton and the Duke of Richmond were particularly good. Taking the whole of the classes, we consider the exhibition of Southdowns to be a good one.

The Hampshires of the Bury show-yard should be shown with some of the Hampshires—if there are any—of the sort bred twenty years since. Nothing could be much uglier than they then were; nothing combines so much size with so much quality of flesh as Mr. Rawlence, Mr. Canning, and other breeders of these sheep now show; it would not be too much to say that the ewes shown by the former were the best of any breed in the show-yard, and if he would put them to the second prize ram, not his own, he would run no risk of losing that extraordinary size and weight of flesh which he has hitherto maintained, but which his first

prize shearling ram would appear, as compared with Mr. Coles's, to be exchanging for something approaching to Southdown quality. The Judges, the same gentlemen who officiated in the Southdown classes say of them :—

The competition for the Hampshire Down Classes was small, the whole of the pens being good, especially the pens of Shearling Ewes exhibited by Mr. Rawlence. In consequence of the improvement which has extended during the last few years in the Hampshire Downs, their symmetry and quality make them nearly equal to the Southdowns.

The Black-faced Suffolks must possess qualities which a stranger knows not of. The men of Norfolk and Suffolk know their business too well to make it safe to assume that these sheep are as bad as they look, and there must be some merit, though not visible, to compensate for all their faults. Still it seems difficult to understand that their good qualities, whatever they are, might not be retained, with some modification at least of the long legs, short ribs, thin necks, bare backs, and naked heads that characterise the Suffolk sheep shown at Bury, and yet it seems that these were considered favourable specimens, for the Judges say :—

The show of Black Suffolks was considered to be superior to any before exhibited; but there is still room for more improvement.

Surely a cross with Hampshire or Shropshire would bring them nearer to the ground, with wider and deeper carcasses, more tendency to fatten, and—crossed with Shropshire, if not Hampshire—more wool.

One point of difficulty in connexion with the sheep classes is not yet satisfactorily settled. The Council have been anxious that all sheep exhibited should have been really shorn after a certain day, the 1st of April, and every exhibitor must certify that this condition has been complied with, and inspectors have been appointed to report and to disqualify all that have not been shorn *bare* after the time appointed. But these inspectors, Messrs. Workman and Bone, and it is impossible to find two men better qualified than those to whom the Society is indebted for undertaking this most disagreeable duty, find this difficulty—the fact of Inspectors being appointed has, with many breeders of sheep, only led to greater skill in deception, and made detection most difficult: the consequence is that only those who try to cut their sheep into form, out of wool grown before the 1st of April, and do it badly, are detected, while the more skilful escape. After the Plymouth meeting it was recommended that the 1st of May should be substituted for the 1st of April as the date of shearing, but in compliance with the wishes of some breeders of sheep this suggestion was not acted upon.

The question must come before the Council again, and the regulation be made absolutely efficient or abandoned. One month later as the time for shearing would be effectual, and all

must then show on equal terms. Hitherto the Inspectors, in their anxiety to avoid the injustice of disqualifying any sheep improperly, have given to all the benefit of any doubt there could be, and in so doing feel that they have passed, as fairly shorn, many about which they were far from satisfied.

PIGS.

The show of Pigs at Bury was characterised more by uniform excellence than by the appearance of any very remarkable animals—some of the classes, the large white breed and those not qualified for the specified classes were only scantily filled, as were those of all kinds for three young breeding sows; but the small white breed, boars and sows, were in great force both in numbers and quality, and as a whole perhaps have not been so uniformly good at any previous meeting. The classes for pigs of a small black breed were, as was to be expected in Suffolk, also well filled, and among a lot of very good ones Mr. Sexton stood pre-eminent for both boars and sows. With so much general excellence it is superfluous to say that the winners were good, or to do more than to refer to the prize list for the names of the successful exhibitors. Nor must I enumerate all the animals marked for approval in my catalogue.*

It is satisfactory to find that the veterinary examination of dentition showed only two cases where the age was greater than certified, and one, evidently an unintentional error, where it was less.

Upon the whole the meeting at Bury was as successful as, in the absence of cattle, could be expected. The exhibition of implements was the largest and best ever seen. The horses numerous and good enough to form a most attractive feature. Leicester sheep fully as good as usual. Southdowns such as might be expected when Lord Walsingham, the Duke of Richmond, and Rigden compete with comparatively new men, and in some classes are beaten. Cotswolds introduced us to previously unknown competitors, who utterly vanquished the breeders from the native hills of these sheep, and suggested the idea that, unless those men come to the rescue whose names heretofore were conspicuous in the prize list, Norfolk, not Gloucestershire would soon be resorted to by those who are looking for first-rate Cotswolds. Shropshires and Hampshires were distinguished by the evidence afforded of their continued improvement; and Lincolns good, but showing how few breeders of them appreciate the wish of the Council to encourage their exhibition. Pigs in most classes good, as they have ever been; in some, the small blacks especially, much better. All this will tend to satisfy the Council that their mission for this year has been accomplished as satis-

* The judges, at a late date sent a brief report, speaking favourably of the show of pigs in general terms.

factorily as was possible. With the expression of a hope that the interchange of ideas between the men of Suffolk and the visitors from other localities will be mutually beneficial, and that the Local Committe will feel how entirely their efforts to promote the success of the show were appreciated by the Council, I must conclude this report.

For myself I can only say that I resign my office as steward with very grateful recollections of the kindness and hospitality which I, in common with those with whom I have acted, have received in the three towns which the Society has visited during my tenure of office—of friendships formed which will not cease with the stewardship, and of the indulgence which I have received from the Council in many points on which I have felt interested—henceforth my part in the business of the Society will be less active, not less earnest.

Chadbury, near Evesham, Sept. 6th, 1867.

Report of the Steward and Judges of Poultry.

The Report of the Judges of Poultry speaks so fully to the quality of the birds shown that it is not necessary to enlarge upon it, but it may be as well to state that much interest is felt in this department of the show, as evidenced by the almost constant crowd of persons round the pens during the week. In consequence of their non-arrival till 7·30 on the morning of the 15th, it was necessary to disqualify 10 or 12 lots of birds; this was most unfortunate, as several of them were very good of their kind; 2 would doubtless have taken prizes.

H. Barthropp, *Steward of Poultry.*

Hacheston, *July* 31.

The Poultry Judges appointed by the Royal Agricultural Society of England offer their congratulations on the display that was the answer to the prize sheet issued by the Society. They believe that the end sought was fully attained; in proof thereof they would call the attention to the fact that
for Brahma Pootras went to Ireland, Scotl
Dorkings was most excellent,
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Judges were disappoint
and Crevecœur; the
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July 30th 1

ABSTRACT REPORT OF AGRICULTURA DISCUSSIONS.

Meeting of Weekly Council, Tuesday, February 27th. Mr. Rams the Chair. A Lecture was delivered by Professor Simoni "Some of the Causes which Produce Disarrangements of the Dig Organs in Young Sheep."

Professor Simonds said: he would in the first instance few general observations with regard to the digestive syst c sheep.

The Digestive Organs.

Sheep belonging to the class designated *ruminantia* have a complicated system of digestive organs, which pass the food from the stomach to the mouth for the purpose of its bein masticated and re-insalivated. We have, first, the rumen or into which the food goes primarily; next the reticulum, or s stomach; then the third stomach; and, lastly, the fourth, or digestive stomach, the others being in fact preparatory o It is unnecessary that I should go into disputed questions whether the food is passed directly from the rumen into the n or is previously passed into the reticulum, and then into the m or whether, on its second descent from the mouth, after bein masticated, it passes into the rumen, or directly into the stomach. I may, however, state that I hold the opinion that the is passed first into the rumen, and that, at each subsequent swall of that food, the matter, however it may be reduced, is still passe that viscus; and the reticulum is nothing more or less than a su of thoroughly masticated and insalivated food to the third and f stomachs, in order that it may be properly digested. When the f passed from the fourth stomach it goes into the intestinal canal, and it becomes subject to the action of certain secretions, which pr change in it by which the nutritive parts are separated fro These nutritive parts, to which the name "Chyle" is itated upon the mucous membrane of the intestines, of their absorption goes on. The fecculent or innutr into the large intestines, where it is retained of time, subject to the further absorption o h it may possess. Ultimately it is voided b of small nodules, which are compressed a of the gut during the passage.

observations will be evident when we co which are commonly known by the mostly in the intestinal canal, and be to some extent acrimonious, c

in contact with the lining membrane of the canal. But not only have we causes of that kind affecting the consistency of the fecculent matter, and the amount of nutriment extracted from the food of the animal, but also very often an irritable condition of the bowels, produced by causes not acting directly on the intestinal canal. Indirect causes frequently produce fatal cases of diarrhœa in sheep, particularly in young animals; and it is therefore important to be able to separate the one cause from the other, and to ascertain whether it is acting directly or indirectly on the intestinal canal.

The White Scour on Turnip Lands.

In the case of very early lambs, losses frequently occur from what farmers term "white scour." When lambs are perhaps not more than four or five days old, there will be an exit of liquid evacuations of a pale colour, which are exceedingly sour, and to some extent even excoriate the parts they come in contact with. This white scour generally happens when the ewes are remarkably well fed; and very seldom indeed when they are being fed on ordinary grasses, or even receiving only a moderate supply of turnips. In the ordinary case of ewes lambing on turnips, they are often supplied with a very large quantity of good turnips, and at the same time with a considerable amount of highly-nitrogenised food in the shape of oats, peas, or oilcake, the object of the individual farmer being to fatten his ewes and his lambs together. This is a system which used to be followed to a certain extent in Middlesex. A farmer, under these circumstances, although he got his ewes into good condition very easily, and could get rid of them in the latter part of the year as fat ewes, yet lost a large number of lambs from "white scour." The real cause of this affection is, I believe, a peculiar condition of the lacteal secretion induced by this highly-nitrogenised food. The milk of the newly parturient animal is rich in an animalised product called *colostrum*, and if we examine milk very shortly after parturition, we shall find that in addition to the ordinary fatty globules which exist in such large numbers, there are present a considerable number of cells of large size filled with granular matter. On the condition of these cells will the colour of the milk depend: if present in large numbers, the milk will have a yellowish-brown appearance; if their number is small, it will be of the ordinary colour. Now, in the ordinary state of things, these cells of *colostrum* very soon disappear, and they are met with very sparingly indeed in milk a few days after parturition. If, however, the animals are kept too well, the period is prolonged, and the young animal is subjected to a disturbing influence. It has been said that these cells exist in the milk, that nature may furnish her own purgative to a young animal, whose bowels are loaded with a peculiar substance, called *meconium*, and there can be no doubt that milk which is rich in *colostrum* has a laxative effect on the intestinal canal. But further, we must regard these cells as agents which absolutely excite fermentation in the milk; and there can be no doubt, I think, that lactic acid in excess is thereby produced, so that when the milk is received by the young animal, a more

than ordinarily firm curd is produced in the stomach. When a young animal partakes of milk, the milk (that is to say, its caseine) is acted upon by the gastric juice, and the first effect of digestion is the coagulation of the caseine; but after a short time the same cause acts upon the coagulum thus produced, and it is broken up or otherwise digested. Now, if you have an abnormal condition of the milk itself produced by a cause of this kind, you will find that when the clot is produced in the stomach of the young animal the gastric juice is not solvent enough to break it up; so that it becomes an indigestible material, often accumulating to the extent of three or four pounds weight. The whey of the milk is passed through the intestinal canal, and is voided with the mucus of the intestines as an abnormal secretion and comes from the intestines in the form of a white fluid. I have seen many young animals fall a sacrifice to this state of things, because not merely had they functional derangement of the stomach and intestines, but absolutely inflammation of these organs. The animals then die of gastro-enteritis, induced by causes of this kind.

For getting rid of the affection, common sense would tell the farmer to alter his management; for you can hardly do anything that will be beneficial to the lambs without paying attention to the health and food of the ewes. Let the nitrogenized food be lessened in quantity, especially cease to use cake and corn for a certain time, and you will find fewer cases of this kind occurring. Thus you will strike at the root of the evil at once.

Something might be done also with regard to the lamb, whose system is ill-adapted to bear up against disease. It should be prevented from taking more milk for a day or two by being taken from the ewe, the necessary support being given it by well-boiled oatmeal gruel, and so on. Antacids should also be given, particularly bicarbonate of potash, which will have a tendency to break up the firm coagulum of caseine in the stomach; and if this treatment be combined with a little gentle aperient and carminative medicine, the case may not be unsuccessfully dealt with. Perhaps as good a mixture as can be given to the lamb for a day or two while it is separated from the mother is a scruple of bicarbonate of potash, with about 10 grains of rhubarb, and from 5 to 10 grains nutmeg. Give this with a little peppermint-water or gruel once or twice a day, and with such management as I have indicated the white scour will generally be arrested.

Diarrhœa.

I pass on to speak of other derangements of the digestive system which lead to diarrhœa in young sheep prior to weaning. In considering the manner in which the animals are managed, attention must of course be paid to the system of farming. In the case of ewes upon turnips when the lambs are strong, the common practice is to use what are called lamb-hurdles, by means of which the lambs can run out of the fold on to the turnips, and return to the ewes at their will. If these turnips have a large amount of top quickly grown the lambs become subject to diarrhœa. On the other hand, if there is an advanced ripening of the turnips, the weather

having been genial, with scarcely any wet, the animals do remarkably well. Particularly is that the case if the turnips run up so as to produce their flowering stems, which the lambs can crop, not only with impunity, but with very great advantage. On the other hand, if the turnip-tops are immature, or only partially developed, or if the weather is wet, food of this kind, given as it mostly is in great abundance, will act as a direct irritant upon the mucous membrane of the stomach and the intestinal canal, and diarrhœa will be the result. Occasionally this functional derangement of the intestines leads to a partial attack of *gastro-enteritis*—in other words, to inflammation of the mucous membrane of the intestinal canal, and the young animal soon falls a sacrifice to the scouring. Here, too, we have only to alter the system of management, by limiting the quantity of green immature tops that are given to the lambs, or substituting some other food. Fortunately at the period of the year when lambs are dropped turnips are very rarely found in this particular condition; but on certain soils and in certain states of the weather it will occasionally occur.

Diseases after Weaning.

Diarrhœa.

After weaning, a large number of young lambs are lost, and from precisely the same cause, namely, diarrhœa. Here we frequently find that several causes are brought into operation, some of them unquestionably of the same nature as those to which I have already alluded, and others totally different.

If lambs are placed on clover or artificial grasses, and if the temperature is not only elevated, but a great deal of watery vapour is mixed with the atmosphere, the animals if they are eating largely of green succulent vegetable matter, particularly if unripe, will become affected with diarrhœa; and nothing less than an alteration of the management will be sufficient to stay the evil.

Vegetable Hair Balls.

But this affection is often induced by another cause. It is not, perhaps, so generally known as it ought to be, that the stems and leaves of broad-leaved clover have a large number of vegetable hairs upon them, and that these, when received into the stomach, are very apt to become agglutinated, and to be rolled into a ball-like form within the rumen. So long as substances of this kind remain in the rumen, or first stomach, it is a matter of no consequence whatever; if they only reach the second stomach, as well as the first, it is also a matter of little moment; but if they pass, as they are very likely to do, into the third stomach, or rather through the floor of the third stomach, directly into the fourth, they often become offending agents to this organ, and not unfrequently pass on, half digested, into the intestinal canal. I do not mean to say that very many cases of diarrhœa are attributable to causes of this kind, but we not unfrequently find a diseased condition of the fourth stomach, and especially of the small intestines, induced by the presence of such bodies.

These substances are similar in form to the hair balls frequently found in the stomachs of fatting calves, but as connected with disease in the digestive organs they are of far greater moment in the case of young sheep than in that of other young animals. A hair ball in a young calf very rarely indeed produces any mischief, unless it be passed or attempted to be passed into the mouth again, to be re-masticated, in which case it will often happen that choking ensues, as shown by several specimens in the Museum of the Royal Veterinary College. The chance of choking does not depend upon hair which is deglutated, or attempted to be deglutated; but the evil actually occurs from the hair as a ball passing upwards from the rumen. I am not aware of any diagnostic symptoms by which the presence of these vegetable hair balls can be detected; it is only through a *post mortem* examination that one can tell that an animal has suffered from such a cause. It is a common idea among farmers and shepherds that lambs die from wool-balls; for though wool-balls are not to be confounded with vegetable hair-balls, the two are produced in a similar manner—that is, by the matting together of the wool or hair; yet hair becomes matted much quicker than wool, and it is only when the animal is living on clover, and particularly broad-leaved clover, that hair-balls are found present to any great extent.

Disease of the Lungs.

Moreover, a large loss of lambs is found to arise from diarrhœa as symptomatic of a diseased condition of the lungs. In investigating this disease, it is always necessary to endeavour to understand upon what the symptoms really depend. For want of this we frequently find a person saying, "I am losing a large number of lambs from scour;" and he believes that this arises entirely from something that disagrees with the digestive organs of the sheep, or that some disease exists in those organs with the nature of which he is unacquainted. When you speak to him further on the subject, he will say, "I have changed the food of my animals; some having died upon such a food, I put the others upon food of a different character; they were upon artificial grasses, and I put them upon natural grasses; they were upon clover, and I put them upon artificial grasses. I have given them corn, peas, and so on; and though they will not eat much dry food, which is not to be expected when they can get green and succulent food at this time of the year, nevertheless, I find that a lax state of the bowels is as prevalent among them now as it was a week or two ago." If you ask this man, "Have you noticed whether your lambs are coughing?" he will reply, "Yes, I have found them coughing very much, and I have observed that the coughing preceded the diarrhœa." This he will say, though knowing very little about what the coughing depended upon. Now, this form of diarrhœa is really due to the presence of entozoa within the bronchial tubes of the lambs; and the diarrhœa is but symptomatic, coming on as one of the last things in the break up of the animal machine. We know that in several affections of the lungs in sheep or other animals the disease

is often accompanied with diarrhœa. In cases where there has not been a healty and perfect decarbonisation of the blood, from structural disease of the lungs, diarrhœa often results. Take, by way of illustration, that disease which in the human subject is known by the name of phthisis. It is well known that some persons who are attacked by this disease have diarrhœa, and when the disease tends to a fatal termination the diarrhœa becomes very copious, and life is sometimes sacrificed through the depression of the animal powers thus produced. Nevertheless, the origin of the diarrhœa is disease of the lungs, which prevents them from performing their proper functions, viz., the proper decarbonisation of the blood. This accounts to some extent for the presence of diarrhœa in sheep.

The Filaria Bronchialis.

Now, this *filaria bronchialis* is a worm, which I am justified in saying is somewhat on the increase. We can readily understand why it should be so: for although we really know very little of the natural history of the worm, or of the best means at our disposal for getting rid of it, we can see the likelihood of the affection passing from sheep to sheep, and from farm to farm. So long as we are unable, through studying their natural history, to get rid of these worms before they pass into the organism of the sheep, so long shall we be contending with a disease which is in reality our master; and we may therefore look for a great increase of cases of this kind. With regard to the circumstances which favour an attack, it is rather remarkable that though on no description of land is there absolute immunity, yet sheep kept in open light-land districts are far less frequently attacked than those kept in enclosed spaces, and particularly sheep which are kept at that particular period of the year already alluded to in parks. With reference to the worm itself, it would appear that even if only one or two of the worms, being of different sexes, find their way into the bronchial tubes, that would be quite sufficient to lay the foundation for extensive disease of the lungs. They lay this foundation by travelling as far as they can through the bronchial tubes (which are continuations of the windpipe) into the very air-cells of the lungs, where they deposit their ova. As the result of that deposition of ova, which may be said to be in myriads, irritation is set up first in the lining membrane of the air-cells, which extends to the parenchyma of the lung. The lung then undergoes a peculiar change: it becomes altered in colour, it will sink in water, and, as an aerifying organ, it is in many parts altogether destroyed. This often takes place, particularly on the fringe or edge of the lung, but not unfrequently in other portions. The brood of young worms is hatched absolutely in the bronchial tubes and in the air-cells of the lungs; so that the large quantity of these worms which are frequently met with in the bronchial tubes did not enter from without, but were produced within. These creatures may, so far as their immediate development is concerned, be termed ovo-viviparous—that is to say, a great number of eggs will be thrown out as eggs; but frequently the young worm will escape from those eggs while yet within the parent. In making a section of the

lung, taking the smallest possible quantity on the point of a scalpel, just sufficient to soil a piece of glass, you will see, in a space of the size of a drop of water, millions of eggs just hatched: and if you examine an old worm, you will see eggs in all stages of development; so that she brings forth her young in a living form, and also in the form of eggs more or less mature. Now, one worm will produce—if I were to use figures here I should have to speak of billions, and even of trillions—an immense number of eggs, and we can therefore easily understand how a vast amount of mischief may be done, even by one or two worms. But now the question arises, How did this one worm get there? Where does the parent worm come from? We must repudiate the theory of fortuitous generation. I no more believe in the fortuitous generation of a worm, or of the lowest form of animal life, than I believe in the spontaneous origin of myself. We must look for other causes. And here we have opened to us a vast field of investigation as yet scarcely entered upon. I have experimented again and again with this class of worms, which are designated by the name of nematoid or hollow worms, and in every experiment I have failed to produce them within the windpipe. I would, then, throw it out as a probable cause of their existence, that a great number of the ova are expelled in the coughing of the sheep with the mucus which is coughed up. Large numbers are, I believe, expelled at each coughing, mingled with the mucous; and I would just hint at it, as a probable thing, that these ova come to maturity to some extent externally to the sheep; that certain plants—it may be ordinary grasses—become the habitat of these creatures in an immature form, and that in this condition they are taken into the organisation of the sheep, and as each entozoon has its own particular locale, these creatures very soon find their way into the windpipe, and a very few doing so are productive of immense mischief. Now, I am inclined to believe that this is really the means by which their presence is to be accounted for. We cannot for a moment suppose that all the worms which we meet in the lungs, for example, under circumstances of this kind, can have entered from without. We cannot suppose the explanation to be that the ova floating in the atmosphere are, after they have become somewhat dry, received into the respiratory organs, and there become matured. There are some things which appear to me to militate strongly against that view of the matter. I have, for example, broken up many old worms when yet alive, and having thus procured eggs in various stages of development, I have placed them in different kinds of fluid, none of which could interfere with their vitality, and have in this manner brought them in contact with the nostrils of sheep. Not only have I done that, but I have used a thick mucus, like gum-water, putting into it a number of living worms, as well as a large number of ova, and have administered this very slowly to sheep, so that it might hang round the mouth, and the worms might travel down the windpipe; but, singular to relate, in all these experiments I have failed. Knowing that nematoid worms are perfected to a certain extent out of the organism, I have been led to the conclusion that it is not improbable—I do not say it is positively the case—that the ova themselves are the real cause of the mischief;

that, being expelled in the manner I have mentioned, they become parasitic to some vegetable matter, and, being thus taken into the sheep, produce disease. This would explain why, if you put fresh sheep on a farm where the worm affection has existed, those sheep become diseased, and the evil continues year after year. We know that weather often has an influence by rendering animals more susceptible; and we know, too, that particular systems of management have an influence; but we are now looking at the matter in an abstract point of view, and I throw out the hint that this may be one cause of the increase of the disease.

There are a large number of worms which affect sheep in particular, some occupying the true stomach itself, under the influence of which sheep will die in a dropsical condition; and from this cause, under all circumstances and conditions, and at all ages, scores and scores of sheep are at this moment being lost. There is no diarrhœa in a case of this description. Within the last few days I have received some worms of exactly the same class as those found in wild rabbits; and I believe that the worm which is found in the stomachs of sheep is one that exists in other creatures, and it may be common to half-a-dozen kinds of animals.

One word with regard to the means for getting rid of the lax condition of the bowels regarded as symptomatic of lung affection. As in this instance diarrhœa is not a disease affecting the alimentary canal, it is not our object to give astringents. No change of food, no medicine, having that object in view, will produce any benefit at all. We must endeavour either to get rid of the worms as they exist in the trachea or in the bronchial tubes of the lamb, or to root out the disease which they have produced within the lungs. The best thing we can do is of course to attempt to get rid of the worms themselves and destroy the broods as they follow one another; and this can be effected only by getting the sheep to inhale a medicated atmosphere. Perhaps, however, I should not say "only," because it is well known that there are certain worm-destroyers which, on being given to sheep, are quickly diffused through the system, and are found beneficial in destroying these worms. But these anthelmintics are often powerless, so that after all we have to come back to a medicated atmosphere, which can be used with great facility, safety, and advantage. If sheep be placed once a day, or perhaps once every other day, in a shed, so arranged that the animals can be got to inhale the fumes of burning tar into which sulphur is cast from time to time, and the atmosphere is thus impregnated with sulphurous vapour, we shall find that we destroy, probably, not the parent or matured worms, but a very large number of those recently hatched. I do not suppose that we have any influence over the ova as ova, but we have considerable influence over the young worms; and I believe also, to use a homely phrase, that we give a "notice to quit" to the old worms. We make their habitat rather untenantable to them, and the result is that they are inclined to quit the body, and so some of them are got rid of.

Then many lives may be saved if we strengthen the constitution

of the animal by generous diet. Here we may take such an agent as turpentine in conjunction with a little balsam of sulphur and a little oil, than which I do not know a nicer anthelmintic. Turpentine, although a diuretic, is found to be got rid of in the animal system to some extent through the medium of the respiratory organs. It is an agent which becomes quickly diffused throughout the system of the animal that takes it, affecting even the breath, the milk, and other secretions. It acts powerfully on the kidneys and on the mucous membranes of the lungs, and is an energetic destroyer of entozoa; so that persons may give turpentine, in conjunction with the old-fashioned balsam of sulphur and a little oil, from day to day, with considerable advantage to their lambs. This must be followed by the use of sulphate of iron in the food of the animal, with corn diet; and much benefit will be found to ensue.

II. The Tricocephalus.

We also find, particularly in the situations to which I have referred, intestinal parasites, which are the cause of the direct irritation of the mucous membrane of the alimentary canal, and are necessarily associated with diarrhœa. There are two forms of worms particularly which inhabit the intestinal canal and lay the foundation for diarrhœa. One of them is a worm called, from the peculiarity of its formation, the tricocephalus, or hair-headed worm. Though common in many animals besides sheep, it exists to a greater extent in them than among any other domesticated animals. These tricocephali are very often a great source of mischief. They burrow their heads into the mucous membrane, and exist more particularly in the cæcum and colon than in any other of the large intestines, and but very rarely in the smaller. Dwelling there, and producing an irritation of the intestinal canal, they cause the hurrying on of the contents of the intestines, and diarrhœa, in fact, results from the local irritation. These worms are with great difficulty diagnosed—that is to say, looking at the sheep, we cannot at first say whether they are or are not the cause of diarrhœa. If, however, a large number of sheep are affected, and a good deal of mucous is discharged with the alvine evacuations, if all ordinary means of arresting the diarrhœa fail, and if the animals, although wasting, nevertheless have a tolerably good appetite, we may come to the conclusion that the diarrhœa is due to the presence of worms; for, as a general rule, when worms exist in the intestines of almost any animal, there is rather an increase than a diminution of the appetite. Generally speaking, when we effect the expulsion of the tricocephali, they come away in a mass. They have a peculiar liking for each other; for no sooner do they quit their hold of the mucous membrane of the intestinal canal than they run together, thus producing a large lump or mass. In this way they are usually expelled; and it is with difficulty that you can separate one of these long-necked worms without breaking it, in consequence of its neck being twisted in all possible directions with that of others.

The Sclerostoma.

Another kind of worm, not so well known as the tricocephalus, but also the cause of diarrhœa in sheep, is the one designated sclerostoma,

hard-lipped or hard-mouthed worm. This also exists in the large intestines, attaches itself by its sucking disc or mouth to them, feeds on the juices of the animal, and lays the foundation for diarrhœa in the same manner as the tricocephali do. Very frequently these two kinds of worms coexist in immense numbers, and I myself have taken great numbers of both from the same animal. Now, before throwing out a hint as to the best means of getting rid of these, I will refer to other worms which are present in the intestinal canal, and about which persons are exceedingly solicitous; I mean

Tapeworms.

They are more common in lambs than sheep. They often exist in large numbers, and I have seen as many as a dozen or so in the intestines of one animal. Their natural history is pretty well made out; they are, in fact, the perfect entozoa arising out of hydatids, those peculiar bladder-like bodies which are met with in different parts of the organism of various animals, and which are nothing more nor less than the scolices of tapeworms. I believe that the dog is infested with something like seven or eight varieties of tapeworm, and, with one exception, I believe the whole history of the tapeworm is known. In common with Dr. Cobbold, I have for some time been engaged in investigating the development of this class of entozoa, and I have by me, as Dr. Cobbold has also, tapeworms produced from various hydatids which have been given to dogs, cats, and other carnivorous animals. We have them at various ages. We gave the hydatids to the dog, and killed him within a certain number of days, and found the product of the hydatids present. And so we followed the development of these creatures from time to time. I refer to these experiments to show that we know something pretty certain with regard to the tapeworm, but little as to the nematoid worm; for as to how these tricocephali and sclerostoma get into the intestines and increase in number, all we know is that they are oviparous, perfect male and female. Take some of the large intestinal worms by way of illustrating this point. You have seen in the horse and in other animals a large worm, nearly a foot in length, very like the earthworm, but very white in colour, and called, because it is like the earthworm, the lumbricoid worm. I have a specimen in my possession of a pig's intestines, with worms in it six or eight inches long, though the pig was only six weeks old. There are not less than between 200 and 300 crammed into the intestines, and the worms are developed to the size of an ordinary quill. I have other worms taken from dogs only three weeks old, and these worms, though they are not lumbricoid, are fully matured. In fact, they had been perfectly formed in that short space of time; but, strange to say, though they are found of various sizes and of perfect form, you never find a young one as the immediate product of these parent worms. Here is an egg which is not visible to the native eye: that egg has to produce a young worm, which is to be developed somewhere; yet we never see it in such a form as to enable us to say that it is a young lumbricoid worm. We know nothing about them; but here is this fact, that if you take one of these worms, cut it up, put it in a jar of water, allow it to remain

there for ten or twelve months, and then examine the deposit at the bottom, which has the appearance of so much decomposed matter, you will see the young worms beginning to exist in the eggs, and not before. Their vitality is preserved. They undergo a subsequent change. The young worm is produced; it becomes parasitic, and enters the intestines and stomach of the animal. So that in reality we open up a vast field of science—one that will amply repay an individual for cultivating it, but which will require a life, or two or three, to make anything out of it at all.

Remedial Agents.

As a means of getting rid of these intestinal worms as a cause of diarrhœa, I believe that great benefit would result from the daily use of salt. Even though the lambs are scouring, and salt is otherwise objectionable, a certain quantity of it mingled with ordinary food will be found effectual in arresting diarrhœa. Besides that, advantage will result from the more direct anthelmintic agents. Let balls, which are preferable to draughts, be made of Venice turpentine, with sulphate of iron and some gentian. Give them to the sheep, and you will find that you bring away these *tricocephali* and *callus-tænia* in very large numbers. Then, having got rid of this cause, ordinary attention and dry food will be effectual in restoring the health of the animal.

Straw as Food.

But besides the forementioned causes of diarrhœa in lambs, we have occasionally other agents that are of an opposite character. Sheep suffer less than any other animals from what we may call an excess of indigestible woody fibre. We will suppose, by way of illustration, that a man has a number of young weaning calves, or under a year old. He is rather niggard. He has heard a great deal about the nutritive properties of straw, and he thinks fit to have it cut into chaff, and supplied to his animals in excess. I know what will be the result. He will have a certain number of cases of diarrhœa, and occasionally sustain severe losses in consequence. That diarrhœa depends upon the direct irritating effects of the indigesta upon the intestinal canal. It is a material that is not properly digested and assimilated. The fact is that straw is straw, and in the body of an animal you can make nothing else out of it. You may rely upon it that a very small quantity of blood will come out of it; whilst there is a great deal of indigestible material in it, which acts as an irritant on the intestinal canal, and produces diarrhœa. Sheep will now and then suffer from similar causes. If a man gives too much chaff and too little corn to his sheep, or if he withholds a certain quantity of green and succulent food at the commencement of winter, there will be frequent cases of diarrhœa. The same amount of mischief, however, is not produced in sheep as in cattle, because sheep, though ruminating animals, gather their food in a somewhat different manner from oxen; they take more pains, in short, in masticating their food. Hence, when sheep are upon pastures, we see them feeding very closely, and masticating every mouthful for a longer time than the ox, which

swallows his food in a mass. Chaff is partaken of in the same manner. In these circumstances a change of food becomes necessary, and acts beneficially. It is not necessary to give astringents, because they do not strike at the root of the evil. Remove the cause, then, and the effect will cease.

Diarrhœa Regarded as a Symptom of Disease.

Now, not only these several causes, and a number of others to which I have not referred, are productive of mischief; but diarrhœa is also very often symptomatic of other diseases. If I wanted the best illustration of this which science affords, I should direct attention to the circumstance of sheep becoming affected with the malady which we term cattle-plague. Here we have a disease which in the sheep is invariably, I believe, associated with dysenteric purging. Hence, we get an apt illustration of morbific matter carried into the organism of an animal, and so deranging its entire system, as to lay the foundation of a fatal attack of diarrhœa. I have thus thrown out a few hints with regard to some of the causes which produce derangement of the intestinal canal, and I know I have done so very imperfectly. I will only say, in concluding, that among our most useful astringents for arresting diarrhœa are galls. Next to the use of astringents stands the neutralisation of the acid secretions which come from the mucous membrane of the alimentary canal in all cases of diarrhœa—without reference to the causes that produce it—by means of ant-acids, particularly bicarbonate of potash, which is a most effective agent. If we feel a disturbance or a lax state of the bowels coming on, we shall frequently find that by abstaining from food and taking a good bold dose of carbonate of soda, the complaint will be checked at once; for the simple reason that the carbonate neutralises the acid secretion which exists, even without reference to the causes which have given rise to the diarrhœa.

The Chairman asked the Professor if he had ever analysed the hair-balls of which he spoke?

Professor Simonds had only examined them microscopically. They were composed entirely of vegetable hairs; the mucus of the intestines glued the hairs together, and converted them into a species of felt.

The Chairman, in reference to tape-worms, said he saw one, 24 feet long, which came from a dog of his, last summer.

Professor Simonds: In oxen these worms attain an extraordinary length. True, they were not common to the ox, but he had seen them come from that animal double the length to which the Chairman referred. The worm known as *Tænia elongata* was so designated in consequence of its immense length.

The Chairman said, among sheep about twelve months old, bred in the mountains, there was a disease known by the name of "the sickness." These sheep lived on coarse food and experienced a good deal of wet and cold; and the loss from this cause was very severe in the hilly districts of the north. When he was amongst the hills some time ago he advised the farmers to give their sheep peas, beans, and things of that sort, and the farmers now said that he was the best

doctor they had ever seen. The sheep were affected with diarrhœa to a very great extent. He observed that Professor Simonds had not referred to the quantity of milk taken by young lambs. His own impression was that they took a great deal too much, more indeed than their delicate stomachs could well convert into food. Sheep that were highly fed gave a good deal of milk, and their lambs seemed more liable to disease than those of sheep which were lean and yielded less milk. Had the Professor noticed that?

Professor SIMONDS replied that he had, and was inclined to think that lambs which had the opportunity of going to their dams as often as they liked would rarely be found to glut themselves. It was not because the animal had taken a glut of milk that they got these large accumulations of curd. In reality it was often seen that when an ordinary quantity of milk had been taken the curd accumulated in the stomach.

The CHAIRMAN said, with regard to the digestibility of milk, it was generally believed that rich milk was easier of digestion than weak.

Professor VOELCKER desired to make a remark or two on the question how far food of the same description—for instance, turnips or grass—at different periods of their growth affected the health of cattle, by producing either constipation or diarrhœa. There was a very great difference in the effects which food of the same kind produced. He believed that the land on which the food was grown had much to do with this; for he knew practically that there were some soils which invariably grew produce that was termed "scouring food." Such were the scouring lands of Somersetshire, which lay upon the lias, and almost invariably had the effect of producing diarrhœa. This varied with the season, and it was remarkable that in hot summers the land became more scouring than at the colder periods of the year. It has been observed that the period most dangerous to the sheep was when they were put on clover or natural grasses, at the time the herbage was making rapid growth. Thus, when warm weather set in suddenly, after much rain had fallen in the early part of the year, there was a rapid development of leaf, and the produce became very sour. He believed that this was not merely attributable to the presence of much water—an opinion entertained by practical feeders—but was also due to the imperfect condition—the want of elaboration in the crude juices of the plant. Having examined that subject he had constantly found that a large amount of crude nutritive matter was present. It was not true, as was sometimes maintained, that unripe food contained a deficiency of nitrogenous matter; the very reverse was the case; if the food were too rapidly grown they would invariably find much nitrogenous matter in it, but not in the form of albumen, of caseine, or of any definite chemical compound: they found it—he could hardly say in what condition, but he could tell them in what condition it was not—it was not as nutritive albumen, or as nutritive gluten, or in any form which was commonly designated flesh-producing—it was unelaborated crude feeding material. Then there was also present in this rapidly-developed young produce a very much larger proportion than usual of saline matters which were taken

from the soil, and were evidently stirred up in the plant, to serve afterwards in the assimilation of atmospheric food and its conversion into sugar, gum, and other nutritive substances. This unelaborated matter and this excess of saline or mineral substances, which often abound in clay, had a tendency to produce a laxative effect upon sheep, and oxen also. Moreover, in very young produce a much larger proportion of vegetable acids was invariably present than in riper produce; and these organic acids no doubt had a medicinal effect when taken internally; there they were converted into sugar and became real nutritive matters. These organic acids differ much in their character; in the earliest stages of growth an acid was produced which gave way to another very similar in composition, but different in its effects on the living organism. The acid to which he alluded (oxalic acid), was found in very young rhubarb; it was not, however, confined to rhubarb stems, but occurred as perhaps the most common and widely circulated acid in the vegetable organism. Within a week this acid—a deadly poison, would pass into the form of citric acid—a similar composition, but different in its effects. The citric was then changed into malic acid, one acid succeeding another, until finally they disappeared, or became neutralised by the very materials which were accumulating in the vegetable organism. The result of these chemical changes in the ripening of the food—changes which had not yet been investigated so minutely as their importance deserved—was that the food became totally different in its practical effects.

In corroboration of what he now said, he might remind them that very early in the season it was an extremely dangerous thing to eat much rhubarb-pie. When the rhubarb became plentiful and cheap, then he ventured upon it—not because it was cheap, however, but because he knew that by that time the oxalic acid had disappeared, and had given place to malic acid—the acid of the apple—or to citric acid, which was extremely grateful to one's constitution.

Mr. Frere considered that the loss of lambs was often hardest to control in the autumn, especially on the richer pastures. He had been informed by a gentleman who farmed good rich grass lands in the Isle of Ely that they used to have such losses from scour in his father's lifetime, that they had almost given up keeping hoggets; but his father being a malster determined to try malt, and it proved to be of so much service, that it had been employed ever since, removing any apprehension about stocking the land with young sheep in the autumn. On his own dry light-land farm he was free from the forms of the malady of which Professor Simonds had spoken, and experienced no practical difficulty until he arrived at the end of July, that is, until the sheep had been over the layers once; from that time, however, difficulties would arise, and careful, vigilant management be particularly required; if the lambs were fed entirely or mainly on the stale layer, diarrhœa would inevitably set in. He met the difficulty in this way; early in April he put some early rape on the strongest of his land, which would best bear it in the warmest months of the year; in the middle of July he folded the lambs on

that at night, giving them a free range for a few hours in the day on the layers, which had already been folded over once. As they chiefly ate the rape they did perfectly well so long as it lasted. Then, when the rape was gone, his next green crop in succession would be early Pomeranian turnips. He had tried pulling some of these and feeding upon the old depastured layer, but diarrhœa set in almost immediately. He wished to ask the Professsor to what cause he would attribute this disease, seeing that in his case it had occurred within a few days of the lambs being made to depend on the foul layer, and that the malady abated directly they were taken off it. Perhaps he might be disposed to attribute it to some form of worms; but the objection to that solution is that the space of time during which the lambs were on the layer was so short, that there was no symptom whatever of any mischief brewing before they went upon it, and that the malady ceased within a day or two after they were taken off. The layer was Dutch clover and trefoil; the time was the month of July last, prior to the heavy falls of rain.

Professor SIMONDS: The fact was pretty well known that in practice it was not judicious to allow lambs to follow ewes, as it was termed.

If lambs were constrained to partake of food where ewes had been before them, injury might result to their young organisms from the quantity of feculent matter which would be lying about, and in process of undergoing chemical changes. That would be a source of mischief; but it was further inferred that the land having been manured on the surface, the young herbage would grow up very quickly, particularly in showery weather. Thus they got an unripe leaf of plant, and this he should consider the chief cause in operation. Indeed, he should look to the manuring on the surface, the rapid growth of the vegetable matter, and its immature condition, as explanatory of the fact, rather than to anything else.

Mr. FINLAY DUNNE said the same rapid growth, with the like effect produced on the bowels of sheep, occurred on the richer lands during the spring months. On the better grazing lands of the midland counties they could not keep their lambs without experiencing a good deal of trouble from scour. Very often they died off in large numbers, as described by Professor Simonds, when apparently strong, hearty, and thriving rapidly, from ten days to a fortnight old; and he believed the cause to be that the land was really too strong and the grass too good for them: it was in a rapidly growing state: it was undergoing changes; probably it was more easily fermented, and so gave rise to a disturbance of the delicate digestive organs of the young animal. He had been very much gratified and instructed by the able and most useful lecture of Professor Simonds. Every year a large number of animals were found to be infested with these creatures, and the great difficulty was to cope with the malady when the flock was being increased. The only way, as it appeared to him, of materially lessening it, was by varying the food, and giving a larger quantity of dry food. He might remark, that he had found great advantage, not only in cases of scouring, but also in connection with worms, in giving sheep a small quantity of lime-water with turpentine. Others who

by his advice had used this remedy had found it answer better than any other. Most persons were too much inclined to rely on medicines, and he agreed with the Professor that they should look more to causes.

The CHAIRMAN in proposing a vote of thanks to Professor Simonds said that, as a practical farmer he quite believed almost everything the Professor had told them; and he agreed with Mr. Dunne, that the only remedy for the evil in question was to endeavour to protect flocks before the disease had got a firm hold.

Meeting of Weekly Council, Tuesday, April 2nd. Mr. THOMPSON, President, in the Chair. A Lecture was delivered by Professor VOECKER on

THE RELATIVE VALUE AND MANURIAL PROPERTIES OF PURCHASED FOOD.

Dr. VOELCKER said: In no other country is the art of feeding so well understood as in England. Foreigners, on coming to this country, are surprised when they look at its fat stock, and still more so when told in what an incredibly short time it is fattened for the butcher. For the superior skill which distinguishes the British farmer in comparison with continental stock-feeders there are several reasons, which it may not be amiss briefly to consider, by way of introduction to this subject. They are, indeed, so well known to us, that it is the more surprising that our continental neighbours seem to ignore some of the most rudimentary principles with which every stock-feeder in England is well acquainted.

The first oversight is "*the proper selection of stock.*" The English farmer has learnt to appreciate the advantage of having well-bred animals to fatten, and therefore abstains from spending money upon coarse, ill-bred beasts, which do not thrive upon any kind of food, and, as the saying is, soon "eat their heads off."

A second point is that the English feeder has learnt that *the sooner he can, by good feeding, prepare his animals for the butcher*, though he may spend more money in a given time, the better it will be in the end; not that he is satisfied with merely giving his stock an abundance of food, but he is very careful in placing before them such mixtures as he has been taught by his own experience are most appropriate to the object in view.

A third point is, that whilst in many parts of France, Germany, and Holland, and, indeed, throughout the continent of Europe, animals are half-starved in their infancy, *the British farmer supplies his young stock abundantly with cake and food usually called concentrated*, or, in chemical language, nitrogenous; nor does he cram young stock with chaff, innutritious grass, and similar bulky food, which on the continent is given too much, to the exclusion of more concentrated nitrogenous food. I should not like to say a word in disparagement of straw as food, which is most valuable in its proper place; indeed, for fattening beasts, which are abundantly supplied

with oil-cake, if hay-chaff is not at command, a certain amount of tender straw-chaff is almost indispensable. Young stock, however, should not be supplied with food which is so poor in fibre-producing substances, as straw is proved to be, and the English breeder seems to have learnt this practical lesson from his own experience.

But perhaps the main reason why the English breeder and feeder of stock excels foreigners so much is, that he is *an eminently practical man*, who, by placing at different times all kinds of food, good, bad, and indifferent, before his animals, has learnt by dint of sheer experience what is best suited to them. On the continent, on the contrary, the science of nutrition has been much more studied than the art of feeding. Very little attention has been paid to practical feeding experiments, such as those conducted so carefully and successfully by Mr. Lawes of Rothamsted, which are quite unique; so that those desiring information on the subject would do well to study the valuable records of his experiments, as published from time to time in the Society's Journal; more especially his paper on pigs, which is quite a model paper on experimental feeding. The art of feeding and fattening stock is a peculiarly practical one, and can only be acquired by practical experience. The scientific experimenter with preconceived notions on the subject of nutrition is too apt to forget that he has to deal with, not merely dead receptacles, but living creatures, with a nervous system, peculiarities of habit, and an organism, which must be considered at the very outset. The whole subject, however, of nutrition is, and probably will continue to be, in a great measure, enveloped in mystery; and so long as we cannot clearly establish principles applicable in every instance, it would be unwise to throw overboard the results of actual farming experience, and to fatten according to the prevailing theories of the day.

It may be instructive to examine the way in which continental physiologists and agricultural chemists endeavour to get a deeper insight into the chemistry of food, and the powers of animals to assimilate flesh and fat, and so on. In studying the process of nutrition, they proceed by supplying animals with what they conceive to be enough food to keep them at their live weight; they then experiment with different kinds of food, the weight of which is arranged according to its composition; and from the results of the weighings they derive general deductions, according to which they estimate the value of the food. In England, on the contrary, even in accurate feeding experiments, the plan is to put before the animals an abundance of food of different kinds, to let them choose what they will take, to ascertain afterwards what has been taken up in the animal organism, and how much has passed into excreta, and then deducting from the total amount of food the matters which remain undigested, or have been altered in various ways in their passage through the animals, the English experimentalist seeks to arrive at some conclusion as to the value of the food usually given to cattle. Now this plan appears to me by far the more rational.

The chemistry of food has engaged the attention of many scientific men. The literature of the subject is very extensive; and to chemists

and physiologists of the highest order, including Boussingault, Liebig, Bishop, and Voyd on the continent, and Lawes and Gilbert in this country, farmers are largely indebted for elaborate and useful researches. Certain principles have been distinctly established by their joint labours, but a great deal remains to be done before we can get a much deeper insight into the mystery of nutrition. We undoubtedly possess certain advantages over the generation which immediately preceded us, and these enable us to select, with greater certainty, the kind of food best adapted to particular cases, whether working oxen, milch cows, or fattening stock. We have also learnt to form a more correct estimate of the real money value of food.

As the subject of animal nutrition is too wide for a single lecture, I shall limit my remarks to THE CHEMISTRY OF PURCHASED FOOD, and shall direct special attention to the fact that the money value of such food is very materially influenced by the value of the food constituents which pass through the animal in the form of solid and liquid excrements. It is well known that the manurial properties of different kinds of food vary exceedingly. Thus the dung of animals fed upon oil-cake, or upon peas, lentils, and leguminous seeds in general, is very much more fertilising than that of straw-fed beasts. Hence it may be useful for us to inquire into the relative manurial values of the principal kinds of purchased food.

The following list probably includes all or nearly all the articles at the present time brought into the market and employed by the British farmer as auxiliary feeding materials: linseed, linseed-cake of various kinds, earthnut-cake (commonly called nut-cake), rape-cake, cotton-cake (decorticated and undecorticated). These cakes form, so to speak, the first class purchased food.

Secondly, we have beans, peas, lentils, and fenugreek. These leguminous seeds form a second class of purchased food.

In the third class I arrange together the farinaceous seeds—Indian corn, wheat, barley, oats; and, by way of appendix, I add malt, malt-dust, bran, and pollard.

Then, in a fourth class, I put together the following materials, which are now and then in the market, and are useful auxiliary foods: palm-nut meal, locust-beans, brewers' grains (which may be had at a moderate price by farmers who are well situated for obtaining them), and molasses.

In every kind of food we find the following classes of food-constituents; nitrogenous, or flesh-forming substances; and fat-producing substances, which may be conveniently divided into two groups, in their order of merit: (1) ready made fat; and (2) sugary or starchy food; ready made fat being much more valuable than either sugar or starch. Indeed, I shall not be far wrong in saying that one part, in weight, of fat or oil is as valuable as a feeding material as two-and-a-half parts of sugar or starch, or any analogous compounds. Among starchy compounds I include the vegetable jelly pectine, and pectinous substances; and not far removed from starch and more digestible pectinous matters is the young cellular fibre, which is digestible to a considerable extent, and ought to be taken into account in estimating the

value of different articles of food. Then we have in all feeding materials the woody fibre, which, being indigestible, possesses no feeding value.

Lastly, we have the mineral matters, which play an important part in the animal economy, inasmuch as they supply bone materials, and also the various salts which are requisite in the formation of blood, and are invariably present in the juices of flesh and other secretions.

On examining these different classes of food, we find that the relative proportions of their chief feeding constituents vary exceedingly. The nitrogenous or flesh-producing substances, as they are generally called, although in reality they do not produce, *par excellence*, butcher's meat, are particularly abundant in all kinds of oil-cake and leguminous grains, more especially in decorticated cotton-cake, and next to it in order, earthnut-cake. The proportion of nitrogen in leguminous seeds very nearly approaches that in oil-cake. Cereal grains contain on the average only half the proportion of nitrogenous substances contained in leguminous products. Now the feeding value of the articles of food given to stock really depends not so much on the amount of flesh-forming constituents, or in other words, on the amount of nitrogen which the different kinds of food are shown by analysis to contain, as on the proportion of ready-made fat, and substances capable of producing it. It must be remembered that in butcher's meat we have invariably a mixture of lean, muscle, fibre, and fat; and the mixture is much more readily produced from food, having a fair proportion of albuminous matter with an excess of starchy substances or of ready-made fat, than from food containing an excess of flesh-forming constituents—albumen, caseine, gluten, or their equivalents. The food, then, which is richest in nitrogen, is not exactly that which produces butcher's meat most readily, or at the lowest cost. The value of oil-cakes depends in a great measure on the amount of ready-made fat which they contain. Hence a foreign cake, poor in oil and very hard-pressed, is not equal as a meat-producing auxiliary food to good English oil-cake not much squeezed in the oil-mill. This perhaps is one reason why hard-pressed Marseilles cake is not so well adapted for the fattening of stock as it is for young stock. The reason why foreign cake is inferior to English cake as a fattening material is, that well-made English cake is generally richer in ready-made fat and oil.

Regarded merely as feeding materials, the various food-constituents follow each other in value in the following order: (1) ready-made fat and oil; (2) starch, sugar, and pectine; (3) nearly equal to starch or sugar is quite young digestible cellular fibre; (4) then come the albuminous substances—gluten, caseine, vegetable albumen, and analogous materials; (5) lastly, we have mineral substances and woody fibre, possessing scarcely any feeding value.

The money value of food, however, as I have already intimated, does not depend simply upon the actual amount of feeding materials which it contains, but also upon the value of the fertilising elements which pass through the animal into dung. Let us, therefore, inquire which

of the food constituents easily pass into dung, and what is the money-value of these fertilising constituents?

First, then, we have to consider whether fat, starch, or sugar easily passes through the animal. They sometimes do pass through. If oil-cake, for instance, is badly bruised, or given too abundantly, a good deal of ready-made fat passes through the animal, and considerable loss is thereby experienced; for, though ready-made fat, and starch, and sugar are most valuable feeding constituents, they absolutely possess no value whatever as fertilising constituents. We should, therefore, aim at as complete assimilation of the fatty or starchy matters in the animal's body as is possible; taking care so to feed the animal that the starchy food constituents may be as completely burnt up or altered as possible.

It may be objected to this view of the subject that several oily substances, such as whale-blubber, sprats, fish-refuse, and similar oily substances, are renowned for their fertilising value. I am quite aware that materials which are *largely impregnated with oil* are frequently used with great advantage as fertilisers; but their fertilising value is entirely owing to the nitrogenous matter which they contain, and not in the least to oily matters: indeed they would be all the better if they contained no oil whatever; for oil, fat, starch, sugar, pectine, and similar things, consist of three elementary substances—carbon, hydrogen, and oxygen—only. They contain neither mineral matter of any fertilising value, nor the element nitrogen, which produces ammonia in feeding-materials that readily decompose. At the best, non-nitrogenous substances can only produce carbonic acid, and this feeding material we have in abundance in the atmosphere as well as in the soil, where it is continually being generated during the decay of the vegetable remains of former crops.

In the next place we have to consider the nitrogenous matter which passes through the animal.

All nitrogenous substances contain, on an average, about 16½ per cent. of nitrogen; consequently they produce, on decomposition, a considerable amount of ammonia. For many years we have known that by far the largest portion of nitrogenous matter passes through the animal and is recovered in the dung. The loss of nitrogen which the food thus sustains has been variously estimated: by some it is estimated at one-tenth, and by others at one-fifth, of the total amount. Experiments recently instituted on the continent, however, seem to show that the loss is not so great—probably not more than one-sixteenth part, if so much. Of course in young stock a little of the nitrogenous food is required for the building up of the muscle; but even in that case the total amount recovered from the food in the dung is very great in proportion to that which is assimilated by the body, or may be supposed to be lost. And indeed some recent experiments, in which everything was carefully weighed, show that the loss is even less considerable than 6 per cent. It must, however, be borne in mind that excrementitious matter cannot be perfectly collected: some loss will be experienced by a slight fermentation, and so on; and a small pro-

portion of the nitrogen in food will also probably escape by exhalation from the lungs and the skin. Very little of the nitrogen of food is, however, lost by fermentation, or is necessarily lost in the keeping of farmyard-manure; the mineral matters, excepting a small fraction only of the total amount of food, pass entirely into the excrements.

Of the varions mineral constituents of food we have only to consider two, namely, potash and phosphoric acid. In estimating the fertilising value of food constituents that pass into the dung, we have therefore to deal with: (1) nitrogen (estimated as ammonia); (2) potash; and (3) phosphoric acid. By ascertaining how much of each of these matters passes through the animal, a very close estimate may be formed of the money value of the dung produced by different articles of food. Mr. Lawes, in a very valuable paper published in the year 1862, gives the average composition of the principal kinds of food; and from the average composition, by making the proper deductions for loss of nitrogen, the value of the food constituents which pass into the dung may be estimated with tolerable accuracy. Indeed Mr. Lawes made such an estimate in a circular which he published some time ago. At that time, however, ammonia was much more expensive, and phosphoric acid cheaper; potash has been cheaper since the discovery of the mines in Saxony. The money estimates given by Mr. Lawes are based on the prices current in the year 1862: ammonia being estimated at 8*d*. a lb.; phosphoric acid, calculated as phosphate of lime, at 1*d*. a lb.; and potash at 2*d*. a lb. In the following estimates I have calculated ammonia at 6*d*. a lb.; phosphate of lime at 1½*d*. a lb., or one-half more than Mr. Lawes' estimate; and potash at 1½*d*. a lb., or one-fourth less: these prices agreeing better with the money value at which other fertilising constituents can now be purchased in the manure market.

Adopting the data which I have found in various publications, many of which have been carefully collated by Mr. Lawes, I have calculated the value of excrementitious matter from one ton of food consumed, and I find that linseed-cake is worth as a fertiliser alone, making an allowance for loss, 3*l*. 15*s*. 8*d*. a ton, or somewhat less than the estimate of Mr. Lawes, who puts it above 4*l*.; whilst linseed, which I estimate at about 10*s*. a ton lower than Mr. Lawes did, is worth as a fertiliser only 2*l*. 17*s*. 9*d*. a ton—a point which ought to be considered in estimating the relative value of the cake and seed as feeding materials. Decorticated cotton is worth as a fertiliser 5*l*. 6*s*. 6*d*. a ton, according to my rates of charge, which are certainly not too high. The ordinary English cotton-cake contains little more than one-half the amount of nitrogen contained in cake made from the shelled seed; it is also much poorer in phosphate of lime, and is worth only 2*l*. 18*s*. a ton. At the present selling prices of English cotton-cake, it is, in my opinion, by no means a cheap food, being much dearer in proportion than decorticated cotton-cake. The manurial value of earthnut-cake, decorticated, is 4*l*. 18*s*. a ton, undecorticated 2*l*. 10*s*. a ton. Rape-cake, which possesses even a greater fertilising value than linseed-cake, is worth, according to my estimate, 4*l*. 8*s*. 9*d*. a ton. Beans, peas, and lentils are worth 3*l*. 2*s*. a ton. All the leguminous seeds

have about the same fertilising value. Indian corn is worth only 1*l.* 5*s.*, wheat 1*l.* 7*s.*, barley 1*l.* 5*s.*, malt 1*l.* 6*s.* There is, therefore, no very great difference in the cereal grains, as far as their fertilising constituents are concerned. Bran and pollard, which are much richer in nitrogen than the fine flour, are worth 2*l.* 15*s.* a ton. Malt-dust, on account of its manurial value, is one of the cheapest foods that can now be bought: after passing through the animal it is worth 3*l.* 11*s.* per ton, while rice-meal is worth only from 15*s.* to 25*s.*, according to quality, and if there is much husk it is not worth so much, since the husk of rice consists chiefly of woody fibre and silicious matter, and is not to be compared to the husk of such grain as Indian corn. Palm-nut-meal is worth as a fertiliser 1*l.* 14*s.* per ton. Still lower is the value of locust-beans, which are worth as a fertiliser about 18*s.* 3*d.* per ton. In the same way brewer's grains are worth 12*s.* per ton, whilst as a fertiliser molasses has no appreciable value.

I think we may derive some useful hints from these estimates. We shall find that the money value of purchased food is very much regulated by the value of what passes through the animal, and that, after all, linseed cake is by no means a dear cake, inasmuch as a considerable portion (fully one-third) of the money expended upon it is recovered in the dung. We may learn also that decorticated cotton-cake, when it can be had at about 9*l.* per ton, is the cheapest cake for those who are anxious to produce good rich manure. Rapecake is also a very valuable feeding material, and cheap, inasmuch as more than one-half of its cost is returned in the manure: at the present time it can be bought at about 7*l.*, and of that 4*l.* is recovered. These are not mere fancy statements, but the result of practical inquiry. The Norfolk farmers pay as much as 5*l.* per ton for rapecake as manure, and no doubt it is worth as much to them.

I consider that sufficient attention has never been directed to the money to be recovered in dung by a judicious expenditure for purchased auxiliary food. I sometimes think with reference to certain materials that the full money value may be in that way re-obtained. If malt dust in particular had no feeding value whatever, it might answer to buy it merely as a manure. Another practical lesson to be learnt is that brewers' grains are worth buying, simply for the manure they make; at 3*d.* or 4*d.* per bushel they furnish an economical manure, and even at 6*d.* per bushel they are cheap; hence it is that the London cowkeepers are very anxious to buy them. Perhaps one of the cheapest fattening kinds of food is palmnut meal, in it we get more fattening material at a moderate price than in oil-cake; but as it is not rich in nitrogenous matter, a little deduction must be made for its inferiority as a fertiliser.

In conclusion, Dr. Voelcker said these were some of the practical lessons that had occurred to him while studying a subject which he had suggested to the Chemical Committee, because of its great importance.

The President said those present were very much indebted to the Professor for the highly interesting and valuable lecture which he had delivered—all the more valuable because it dealt with a matter that

had never been sufficiently considered by the Society. There had been a great many discussions upon the value of different kinds of food for mere feeding purposes, and there had been frequent analyses of such food; but sufficient prominence had never been given to the value of the residuum. They all knew that one man could feed animals at a profit, while another, under the same circumstance, experienced quite a different result. He remembered a discussion that took place at the Central Farmers' Club on the cost of feeding animals; and there was a difference of at least 50 per cent. in the extreme costs brought forward. Various articles differed so much in cost that it had always been considered a great point to economise as much as possible, in order to prevent the value of the food going into the manure. The value of manure was 5*s.* to 7*s.* per ton, the value of food would be about 12*l.* per ton, and the value of beef about 8*s.* per stone, or 64*l.* per ton. It was clear that, if one could turn an additional portion of the food, by good management, into beef, it was very desirable. The lecturer had shown that in certain kinds of food there were many important elements, very good as beef and mutton-producers, that were combined with other elements which, though of no great value as food, were valuable for their manurial properties. Perhaps it might not be more costly, in the end, to buy food which had great manurial value, combined with an equal quantity of flesh-producing elements. This was a very important point for consideration. They were all, probably, alive to the importance of not using a too highly concentrated food. Some agriculturists made great mistakes on this point, and had failed egregiously in cattle-feeding, by not mixing highly-nitrogenised compounds with sufficient quantities of food of the woody-fibre quality. It was a significant fact that the instincts of an animal invariably led it not to take more than was sufficient of highly-concentrated food, while it would afterwards turn to stubble, straw, &c. On behalf of those present, he begged to thank Professor Voelcker for his valuable lecture.

Mr. Randell said it was always very gratifying to find the results of science corrobating those of practical experience, and the general effect of the lecture had been to effect this in a remarkable degree. With reference, however, to the comparative value of linseed oil-cake and other foods enumerated, his experience did not run paralled with the lecturer's scientific examinations. All farmers knew that there was a marked difference between a portion of land where sheep fed upon oil-cake had been depastured, and another portion of the same ground occupied by sheep that had been fed upon roots or similar food. This matter had been put to the test for generations, and nothing equalled good linseed-cake in manurial value. As to straw being adapted for young stock, his own impression was that it was only suitable when given in conjunction with cake, a practice which the Lincolnshire farmers find to answer very well, imparting vigour to the constitution. Indeed, it was now absolutely essential to keep young stock upon straw, as they had not sufficient hay to give them. As to cotton-cake, whether decorticated or not, it was not a safe food

for young stock. His idea was, that in considering these matters they should start with a certain money value, and not the weight of the stock. He had frequently and carefully tried the effects of different kinds of food in what might be termed the manufacture of mutton, and in every instance linseed-cake had beaten everything else hollow. As far as his experience went, carob beans, notwithstanding the amount of sugar they contained, were little better than straw: and added nothing to the weight of the sheep as compared with roots. In conclusion, he remarked that in manurial value nothing was comparable to oil-cake.

Mr. Torr said his experience of cotton-cake was that it was not half so cheap as good English oil-cake. The merit of feeding mixtures depends, not on the predominance of one particular thing, but the proper combination of various substances. In feeding a cart-horse the animal's digestion should be consulted, and he found that to crush all corn and use it with a little vegetable matter or salt, added at least one-third to its value. Again he had found sprouted barley a third better than barley itself, and he had used it for the last quarter of a century, in spite of malt-taxes. After remarking that the lecturer had let down English linseed-cake rather more than it deserved, Mr. Torr concluded by observing that it was not possible to keep old manure without its losing nitrogen, and if it were highly concentrated and well made, it was not right to subject it to too much exposure.

Mr. Holland, M.P., referring to the fact that a young animal would take large quantities of straw, he remarked that it showed how unerring Nature was in her laws. When rich, stimulating food was given to cattle at an early age, the animal showed his sense of its artificial character by often leaving it to feed upon straw. He feared that as a rule agriculturists did not know so much of science as they should, and believed it was absolutely essential that that they should be acquainted with the elements of the materials they used for feeding. This would enable them to judge whether they were acting in a mode that would repay them, or were expending too much upon highly nutritious food, without taking the question of bulk into consideration.

Mr. Millbank, who had made experiments chiefly as an amusement in the feeding of stock upon various kinds of food, thoroughly concurred in the remark that there was nothing like linseed. Although his sheep undoubtedly throve on cotton-cake, he had had several lamentable accidents in consequence of using it (chiefly producing inflammation), such as he had never known with linseed. To animals kept in confinement, cotton-cake was simply injurious, and sheep kept in the open air did not thrive anything like so much upon it as they did upon linseed. Indeed many animals absolutely refused to eat cotton-cake: to obviate this he steamed the cake in a portable boiler, and then the food was somewhat better relished, but not in the same way as linseed. With animals it is much the same as with us—what we like we thrive upon. At any rate, they would thrive least of all upon food they partly ate and partly left. After remarking that the

lecture had convinced him that it was better to keep manure covered than exposed, he concluded by observing that in his experience hay and straw were of little value as manure.

Professor VOELCKER, in reply to a question by the preceding speaker, said that the value of straw as manure might be taken at about 8*s.* per ton, but hay, which was richer in nitrogen than straw, would be about 15*s.*: it was therefore of little value as manure.

Meeting of Weekly Council, Tuesday evening, April 30th. Mr. THOMPSON (the President) in the Chair. The SECRETARY read a paper, contributed by Mr. S. SHELLABEAR (agent to the Earl of Leicester), on

RECLAMATION OF LAND FROM THE SEA.

The inclosure of certain land at Holkham was commenced by the Earl of Leicester, in the summer of 1856, by the erection of about 150 yards of embankment at its western end, excluding the sea, which flowed over it in that direction from Holkham Bay. At this time the land was protected from the sea, on the north side, by a long range of sand hills of considerable width and height, covered with marram, the growth probably of a long series of years; and there is, perhaps, no more secure protection against the sea than these hills, if ordinary care and attention be paid by repairing with rows of faggots the occasional damages made from time to time by currents of wind, and in planting the newly-drifted sand with marram. On the south were grass-marshes, enclosed many years since, and the whole of the eastern end was open to the shifting channel of Wells Harbour, which formed its boundary in that quarter to a length of a mile and 200 yards. The embankment here was the heaviest portion of the work connected with the inclosure: it was commenced in the spring of 1857, and completed in the autumn of 1858. It starts from a point at the western end of Wells Quay, and runs in a straight line alongside the Channel, nearly due north to a high shingle beach, forming the eastern end of the sand hills, and crossing the old channel twice in its length, a new one having been previously cut to the eastward. The south end of this bank being upon the high level clay deposit, is formed entirely of that material for a distance of about 400 yards, but the remainder of it is built upon the sand, and is formed entirely of sand inside, protected on the sea side by 2 feet thickness of puddle (dipping at the foot 5 feet into the sand), and on the land side by one foot of puddle. The width at the top is 5 feet. On the sea side its slope is 4 to 1 for a distance of 8 feet from the top, and 5 to 1 for the remaining distance; upon the land side the portion made in 1857 had a slope of 2 to 1 to a distance of 8 feet from the top, and then 3 to 1 to the level of the ground; the portion made in 1858 was formed throughout to a slope of 2 to 1. The upper portion of the slope upon the sea side, and the whole slope upon the inside, were covered with grass flag, cut 3 inches thick. The top of the embankment and the 5 to 1 slope on the outside were covered with shingle. Experience has shown that sand is the better material

for the construction of these banks, no settlement having occurred in the large one so formed, while the smaller one, entirely of clay, has required additions to be made to maintain the original dimensions.

The sluice is in this bank, towards the south end, and is built in the clay upon piles: it is a barrel-arch of 4 feet 6 inches diameter, with a self-acting sea-door, and a second door upon the inside, raised or dropped by a screw. Besides carrying off the water from the 580 acres of land comprised in this inclosure, it is required to discharge the drainage water of 1000 acres of grass-marshes and the supply from strong springs upon them. It is found to be too small to do this in the short time during which the tides will allow it to work, and besides has a settlement in the centre; it is therefore contemplated to replace it by an arch of a larger size. The whole of this work was executed by Messrs. Buxton, of Manchester, from the designs and under the superintendence of Mr. Arthur Saunders, of King's Lynn.

This bank has not received any serious injury since it was completed, except during the winter of 1862-63, from the water inside, after the breach made in December, 1862—in fact, no repairs have been required beyond the occasional renewal of the flag and shingle when washed away, and the necessity of maintaining the shingle, which protects the foot of it to a higher level than was originally contemplated. It should, however, be stated that it is but little exposed to the action of the sea, its sea-face being towards the east and adjoining the channel, on the opposite side of which are uninclosed marshes but rarely covered by the sea, with the additional protection of high sand-hills in the distance. The highest tides (which alone cover these uninclosed marshes) occur only with a west or north-west wind; in an easterly gale, therefore, there is no expanse of water to break upon the bank, and in a gale from the west or north-west it is to a great extent self-protecting. The extreme north of this bank is connected by a high bank of shingle, with the sand-hills forming the remainder of the northern boundary.

It was through this bank that the breach was made by the very high tide of December 22, 1862, which at the same time also broke over and swept away the short bank at the west end of the inclosure. The latter was speedily replaced; but the shingle bank, when once broken over, wasted rapidly to an extreme depth of 28 feet in the breach and a width at the upper part of 125 yards, and its repair was a work of greater difficulty. The breach was successfully closed in the month of June following, with shingle, conveyed to the spot by two lines of tramway, from an average distance of about half a mile. The new bank thus formed, having a slope of 12 to 1 on the sea-side and 5 to 1 towards the land, has stood exceedingly well up to the present time, costing but little for repairs. Marram is rapidly growing upon it, and in a very few years it will probably become a high sand-bank, with a strong base and face towards the sea beneath the sand, and standing about 5 feet above the highest tides.

Of the 580 acres inclosed, above 200 acres adjoining the old grass-marshes were a strong clay loam, 80 acres mud land (originally skirting the high clay lands), 170 strong blue clay, or clay-loam, buried beneath

the sand to a depth of from 6 inches to 3 feet, and the remaining 130 either shingley stones, or sea-sand, to an unknown depth. A very large portion of the land inclosed was, therefore, either almost worthless or requiring considerable outlay to bring it into cultivation; moreover, from the meeting of the tides from the east and west upon this spot, it was intersected by several large creeks, and the best portions of it by innumerable small ones.

In the autumn of 1859 the land was laid out for division into fields. One road was formed, passing through the entire length, and crossed at right angles at intervals of about 500 yards by two others. These roads are each 30 feet wide, and are bounded on each side by a ditch. The lands between are again divided by a ditch into fields, varying in extent from 10 to 20 acres. Every field, therefore, has access to a road and is square—two very important advantages with steam-cultivation.

In bringing it into cultivation the next operation was to fill up the large creeks throughout the farm, sand being brought from a distance where necessary by means of a portable tramway worked with horses, or moved from the adjoining lands, where available, by barrow roads: in either case the creek was ultimately brought to the level of the land on each side by a coating of soil of similar quality. In the same way the small creeks which appeared only in the stiff lands were filled up, or else by digging,—and thus reducing the level of the adjoining land. By the summer of 1862, a large breadth of this land had been brought into cultivation; coleseed, peas, wheat, and oats were grown upon it, and a further portion was sown with wheat—when the sea again came over it. Up to this date the crops were better than they have been at any time since, and it seems probable that the cultivated lands, especially those which had been subsoiled, became more strongly impregnated with the salt than when in their original state. The damage done to the watercourses and roads was inconsiderable; but the land had become so thoroughly saturated as to be incapable of bearing horses until late in the spring, and the roots of autumn-sown corn were destroyed by the wet and salt in the land.

Underdraining, which had been done partially before, was now systematically commenced, and up to the present time about 230 acres have been drained with 1¾-inch pipes, at a distance of 12 yards in the clay and 24 yards in the sandy subsoils—nearly all the drains emptying into the ditches. The fields being all flat, considerable difficulty was experienced in maintaining a regular and proper fall in the drains, the slightest dip causing the drain-pipes to silt up in the sandy lands. The plan now adopted is to set out the level of the outlets in the ditches, and a point 4 feet above the bottom of the drains to be cut across the centre of the field, with a spirit-level, adding the rise to be allowed in the drains. From these two points given him, the foreman is enabled to give an even fall to the bottom of the drain throughout its length, by placing a T staff 4 feet long upon the level point at the outlet, and having a similar staff moved up and down the drain, aligning it upon the level given him in the centre of the

field. Four levels only are given in each ditch, and four across the centre of the field, the remainder being put in with the T staves in the same manner. By this means the work is satisfactorily done, and the foreman is able to superintend the whole, check the levels of every drain, and assist a second man in laying the pipes in the drains, of which about 16 to 18 chains are cut every day from April to August, the work being impracticable in winter.

Four hundred and twenty acres of the land have been cropped, but only 340 are at present under cultivation; the remaining fields are being treated as follows: Some of the heaviest clay lands are being sanded to a depth of 3 or 4 inches by means of the portable tramway (two horses drawing a load of from 4 to 6 tons), 8 or 10 inches of sand being taken from the sandy fields for this purpose, and to bring the clay beneath within reach of the steam-plough. In other fields where the clay is at a greater depth, pits are sunk, and the clay is barrowed upon the land to a depth of 5 or 6 inches (when solid), the surface-level having been previously reduced by barrowing the sand into the last pit sunk; in other parts where the clay is from 12 to 16 inches from the surface, or where the sand is not required for the heavy lands, the ground is trenched, and from 8 to 10 inches of the clay brought to the surface: but in these cases, from the frequent occurrence of creeks in the clay below, the sinking of a pit is often necessary to complete the field and make the soil equally good throughout.

With respect to cultivation but little at present can be said. Good crops of wheat, oats, barley, coleseed, turnips, mangold-wurzel, and clover have been grown upon the land, both before and since the winter of 1862; but it was not until the summer of last year that the land can be said to have recovered, to any extent, from the flooding at that time. As soon as the fields have been drained, they are broken up with Fowler's steam subsoil plough to a depth of 16 inches, allowed to lie the winter, and put under crop the following year.

Since the erection of the main bank, the work has been all done by Lord Leicester's own staff and labourers, with the surplus labour of the immediate district, under his own personal direction. It has necessarily, therefore, occupied a considerable time; and no steps have at present been taken to reduce the cropping of the land to any system.

Mr. R. B. Grantham, C.E., F.G.S., was very glad to lay his practical experience on the reclamation of land from the sea, and the formation of tidal and other banks before the Society. Mr. Shellabear's paper had a special local bearing, and gave an appropriate example of the reclamation of land on the coast of Norfolk, showing at the same time that there had been some failure, and that the bank had proved very expensive. The question, on the whole, admitted of very general treatment; the practice of enclosing lands from the sea being extremely ancient—a matter of interest even in the days of the Romans. At the present day it had lost none of its importance, but demanded more and more the study and skill of the engineer. There would always be vast difficulty in the prosecution of the work, because in many cases the engineer was brought face to face with that powerful

enemy, the sea, whose opposition never tired. When such a work was contemplated there were several considerations which ought not to be lost sight of.

First, the question of area—whether it was worth while to make an expensive bank to reclaim a certain number of acres? Then the value of the land to be worked for agricultural purposes. In his own experience, on the coast of Essex portions of land had been reclaimed at considerable cost, but a long time elapsed before it could be utilised by the agriculturist. In these instances the land was rough in itself, and seemed to retain the salt of the sea so long that it required long exposure to air and rain to disperse the salt before it was fit for cattle to graze upon. On the other hand, in other cases the land had been brought into cultivation almost as soon as the sea had been shut out; he remembered a peculiar example on the banks of one of the large rivers in Ireland, where the tenants of the landowners ran up small walls, and shut out the sea; by this means the mud was enclosed, and the next year the farmers were able to raise a crop of wheat. In this particular instance he attributed the success to the fact that the river runs over a large bed of limestone, and brings down a deposit which neutralised the effect of the salt. The soil, too, was very rich, and under these circumstances perhaps it was natural that the crops would take almost immediate effect. Instances similar to this he believed had occurred in Norfolk.

The nature of the soil which the rivers brought down into the bays that were to be reclaimed was a third, and highly important consideration. Limestone always neutralised the salt, but there were materials often brought down of a totally different character.

Much skill was required in determining the kinds of banks to be used for different places; scarcely two cases admitting of precisely the same treatment; the surrounding circumstances being of the most varying description. Hence anything like classification was impossible. Generally speaking, embankments might be treated under three heads. One was an embankment of earth against the sea with large slopes, and perhaps flat fore-shores, where the waves did not break with great force, in which case the work might safely be done by sodding, and other similar contrivances. This method was as inexpensive as it possibly could be. The second method was banking against the deep water of the sea. This work required to be stoned with considerable batters on the one side and of considerable strength on the top, the width being generally sufficient to bear the blow of heavy waves, even at a considerable elevation above them. The back slopes of these banks were of pretty much the same kind, because a foreshore was really the portion that received the blow of the sea, and was therefore more likely to be injured. It was here the engineer found the greatest trouble in resisting the opposing force. The third kind of embankment was the stone walling, or the upright wall, which was of all the most difficult of construction. There was a difference of opinion amongst engineers as to the precise form these walls should take. He was just now superintending the construction of a sea-wall nearly a mile long in the Isle of Wight on behalf of the Government. It was

a wall to preserve the land from being washed away by the sea, and belonged fairly to the subject under the description of lands now being discussed. The difficulty experienced in building this class of wall arose from various causes: there were great risks of its being blown up, and the expense altogether was so great that it was only in exceptional cases the method could be resorted to.

Another kind of banking was by the sides of rivers where the waves were not very destructive, but where it was quite essential to have a most careful construction to prevent the flood from overflowing the side lands. At the entrances to large rivers it was sometimes necessary, although there was no exposure to the sea, to have careful stoning, because the work was frequently tested by heavy seas. In the river Crouch, in Essex, they took great pains to stone the facings, because the stream, though not wide, was deep. The sea washed the banks there in a peculiar way, coming from the German ocean with a sort of cutting side-wave, that probably had a more wearing effect upon the face of the stone than if it came directly upon it. A railway on the Humber was made in the same way. The stones were placed in the line of the stroke of the sea to break the blow, and to save the direct face of the stone from concussion. This had answered remarkably well.

The value of earth walls depended entirely upon the locality. Mr. Shellabear mentioned that sand had been found to be the best substance. He (Mr. Grantham), however, did not agree with this, believing that the working of such a material was attended with great difficulty. Of course, much depended upon the mode in which the faces of the banks were made. A good sodding, in some cases, might be made from the marram mentioned; and if it could be got to grow in time to save the bank from injury, no doubt it was one of the best protectors it was possible to get.

He had been called upon to prepare plans for fencing off some accumulated land in the Humber. The land (an island) had accumulated from the sea; and a wall was built round, which it was proposed to extend further. The sort of sod that had been referred to seemed to be the best adapted for the purpose, and he had no doubt they would be able to place it at a very small slope. A wall had been in construction for some years on the principle of pitching it with stones. In the first place, for the purposes of temporary protection, faggots were used with great advantage. Groins were also employed, and they acted well in protecting the foundations from wear and tear. The Morecambe Bay Railway might be instanced as a case where a good deal of land was recovered by banks of facing stone and also of groins. He had himself at the present time superintendence of a bank at Fleetwood which had been successful to a certain extent.

Several circumstances of a secondary character operated in the erection of walls, which, if not properly attended to as minor matters, gave vast trouble and expense. Particularly might be mentioned sluices and culverts for drainage. Sluices were seldom put in at sufficient depth; and often the capacity of the drains was not properly regulated. It frequently happened that the sluices were cheaply

made, and were merely effective while the bank was being made; afterwards they were sources of perpetual trouble and cost. He himself had some time since, to repair works of this kind that in the first instance cost but little, while the repair alone cost 700*l.*, simply because of a want of attention and foresight in the original builders.

Having gone carefully into the question of outlay, he was of opinion that, except in the case of extraordinarily good lands, an agriculturist should not go beyond a cost of 20*l.* per acre in making a bank. This might be considered a rather high figure, but he had known it pay in a case of large reclamation. The land must be pretty good land to allow of such a result, and be brought quickly into cultivation, all the work should also be well done, so as to incur as little outlay for annual maintenance as possible. Some lands were done at a much cheaper rate, but it was doubtful whether the cheaper scheme was not actually the dearer method. He called the attention of every agriculturist interested in these matters to the recent Act of Parliament, by which a combined system could be established for the purpose of bringing about extensive reclamations. An individual enclosing land would do so at his own cost and risk, but there was no reason why he should become thus involved. The Commissioners of Sewers appointed under the 23rd of Henry VIII. had been continued, and the powers of the Act had been increased by the Land Drainage Act of 1861, enabling landowners who were interested in a piece of reclaimable land to combine to execute the work of enclosure, being equally taxed to defray the expenses. His experience of inland rivers had taught him that there was great advantage to be gained by such a union of landowners. He recommended all who felt a concern in the question to look into the Act, and become acquainted with its provisions. The advantage was that in combining in a work of this kind every contributor took his part, not only in the cost, but in the management and benefits to be derived from the prosecution of the work in a systematic way. The Inclosure Commissioners had the sanctioning of this Act, and therefore everything was done in a public manner. The operations of the Act could be carried out without difficulty, and the result would be the improvement of inland rivers, and the reclamation of land from the sea, the latter being, of course, the original intention of the Legislature in the time of Henry VIII. No doubt there were a great many persons having coast lands, and large areas of border, who would be glad to combine to borrow or expend money for their reclamation. The Act to which he had referred would show how this could be done, and the general interests of agriculture would be promoted thereby.

The PRESIDENT: You did not say what slope you would recommend against the full force of the open sea. In the Humber, which is little more than a tidal river, the same slope of course is not required as in the spot where you have a heavy sea. What slope do you recommend in the case of open water?

MR. GRANTHAM: It is difficult to speak with precision, but I should say that somewhere about two to one, if well stoned, with some foreshore.

The PRESIDENT: Have you directed your attention to the preservation of banks where they are nearly undermined by the waters, like the river banks in Holland?

Mr. GRANTHAM: I have never had any experience of that description of banks. In some instances, where I have had to deal with land floods, and where the landowners wished it, I have introduced culverts which would let in flood water when they wished to inundate the land. The sluices were self-acting, and occasionally there were land sluices, too. The sluices were, however, very numerous.

Mr. LAWRENCE said there could be no doubt the Wash was a fruitful school for engineering of the description connected with the reclamation of land, and experience of the most useful character had been acquired there. Sir J. Rennie, Mr. Fowler, and some of the other eminent engineers had attempted too much there, when they endeavoured to grapple with the ocean at once. They struck a line across the estuary of the Wash, and in one instance they spent 14,000*l.* in making a fragment of an embankment which was washed away with a single tide. The quiet processes which were now being followed to reclaim the land were very instructive, and they would probably lead eventually to the saving of that immense tract of land which once had the designation of Victoria County. This could only be done by degrees, and by following the operations of nature slowly. He did not believe in some of the great works that had been undertaken of building large sea walls, and grappling suddenly with a tidal ocean with 26 feet rise and fall. In a sea-girt island like ours, such wonders could not be expected. We must proceed as it were terrace by terrace. The expenditure of hundreds of thousands of pounds in the Wash, proved how great were the mistakes made in the reclamation of lands. The drainage of the Fens was one of the greatest works in the country. The work undertaken by the Norfolk Estuary Company was not surpassed by any work in Holland for the drainage of high land lying behind the sea; but their shares at the present time were only worth a few shillings, and hundreds had been bought at half-a-crown each. The general question of land inclosure closely concerned the Society and its supporters, because all agricultural topics were strictly economical questions. Equally important was the question of the President as to the undermining of banks by the water; the only thing to do was to give a good foreshore. Of course, if the occupiers of land chose to go to more expense they could stone the front of the bank and make an effectual barrier against the sea, as they did in Holland.

Mr. HAWKSHAW said it was impossible to lay down general principles regarding slopes, because so much depended upon material. The sand of the sea-shore made its own slope, and that was six or seven to one. This proved an effectual barrier against waves if it was long enough. He could give one piece of information respecting slopes in works of great magnitude. In Holyhead it was found that stone thrown into the sea in deep water gradually assumed three kinds of slopes. At about 5 feet below the water it was six to one; deeper down it was three to one; and very deep down it was one-and-a-half to one, showing that everything depended upon the force of the water and waves

and the kind of material. If the material had been softer the slopes would have been flatter. Neither could general rules be laid down as to where land could be reclaimed. All that could be said was that if the land was worth 30*l.* an acre when reclaimed, not more than 15*l.* or 20*l.* ought to be laid out upon it. If the cost was greater, it was much better to buy land ready made. Slopes covered with soil and sods were, in his opinion, utterly inadequate to resist the sea, unless there were a very large foreshore and shallow water. If the foreshore was flat and very wide, an embankment possessing a slope of two to one covered with sods was practicable. No slope of such a description, however, should be relied upon to resist the action of the sea. In the Mediterranean the French made all their barriers against the sea by blocks of stone of some 20 tons each, which they found stood to a slope of one to one, and if they were a third the size they would be two to one, and so on.

Mr. FRERE said the outline of the sea-wall at Algiers was at first concave; but it had been found better to substitute a convex outline, along which the waves would run, instead of gathering inwards towards the centre of the curve with concentrated force.

Mr. HARDING said he had had considerable experience of the reclamation of lands during many years' residence at King's Lynn. For twenty years he had had a considerable portion of the fen lands under his control, and had, in the capacity of contractor, executed nearly 200,000*l.* of work. His first undertaking was a sea embankment near Louth. It was at the entrance to the Humber, and there were undoubtedly different slopes there. The first portion of the bank was silt; then they came to a strong clay; and the slope varied from six to one to three to one, according to the position and the manner in which the bank was struck by the tide. On the Norfolk coast, between Cromer and Wells, there was a bank 4 miles long, and there the slopes were five to one, the material being of clay. In Norfolk and Lincolnshire they saw nothing of stone, which is too costly for reclaiming the land for agricultural purposes: 40*l.* per acre would never cover the expense. In 1839, he remembered, Sir John Rennie devised a plan for inclosing several hundred acres of land on the Wisbech river. It was a bold project; the proposition being to make an immense bank, and cut off the whole of the sea. The contract was undertaken for something like 60,000*l.* Every practical man who knew the Fen country said it was impossible to carry it out, because every time there was a spring-tide the large tract of land was covered with water. When the work was partly done it was found that the back water was so great that it was impossible to proceed, and the contractor was ruined. The way to do it would be to run across small embankments, which could be cast up by tool instead of barrow work. This would divide the work into sections, and largely increase the chances of success, because the area of the waterway was gradually reduced. The land would thus be reclaimed piece by piece. The benefit of land depended of course a great deal upon what the land had cost. Sometimes land could be bought from the sea at 2*l.* or 3*l.* per acre. On portions of the Norfolk coast the land was very rich;

while on other coasts it was very poor and miserable. On the Essex coast all the surface was impregnated and poisoned by something that came from the oysters,; he knew a piece of land that was enclosed on which millions of ant-hills had since risen, costing about 3*l.* an acre every year to level them. The grass did not grow till late in the season, and as soon as the hot weather came, the land began to crack. The consequence was that no tenant could pay his rent. In Norfolk it was different, because there was a sufficient quantity of alluvial soil to make the land pay well. Various reasons were given for this richness. His opinion was that the sea had nothing to do with it. There were two sources to which he looked: one was, the matter washed out of the drains into the river, and the other, the animaculæ deposited. It was possible to achieve great results by the judicious enclosure of land. Some time ago he was asked to make a certain embankment; but, as a practical man, he declined. A London engineer came forward, and, although he was told the work was impracticable, he undertook to do it in six weeks, at the moderate cost of between 400*l.* and 600*l.* The gentleman wished to make an earth embankment with brick-bats and faggots, and a wooden tunnel at the bottom. The work went on for 16 weeks, 4000*l.* was spent, and the first tide that came swept every particle of the bank away. He mentioned this to show that, after all, practical experience was the chief thing to guide those who attempted the reclaiming of lands.

A great deal more might be done in improving our rivers; the chief thing was to train them: as a rule the back waters were not sufficiently concentrated to scour a deep channel. Faggots, if used, might be placed at a slope of about one to one; and it was astonishing how well they stood. Some gentlemen were great advocates for faggot jetties; but they had a tendency, when the water passed by, to the cutting of the bank between the jetties. It was better to have no projections, if they could be avoided. In various places where the water pressed hard, piles might be used.

Mr. Holland, M.P., agreed that this was a question of much interest and importance to agriculturists generally, and it was specially valuable to the Society; our population was increasing every year, but our island did not increase, except through these adventitious circumstances and scientific achievements, whilst a large area was taken annually from agriculturists for the purpose of building. Hence the importance of gathering together all available facts as to the means by which our waste lands might be made serviceable. One or two interesting points had arisen out of the discussion. One was as to the value of silt, and another remark showed the importance of applying animal matters to the land for the production of vegetable substance. In reclaiming the land from the sea they were providing additional area, and at the same time a manure to enrich it. He moved a vote of thanks to Mr. Grantham and Mr. Shellabear for their addresses.

Mr. Clayden, who seconded the motion, said he was connected with the Norfolk Estuary Company, whose depreciated shares had been mentioned during the discussion, and he begged to state they were not in quite such a bankrupt condition as had been represented. The

company was working slowly in the reclamation of land, and they felt assured they should be able in a few years, from the silting-up of the land, to add to the value of the county of Norfolk.

The PRESIDENT put the vote of thanks, extending it to the gentlemen who had assisted in the discussion. He regretted that the attendance was so small, and thought the Council would have again to consider whether it would not be well to alter the hour at which the meetings were held.

A vote of thanks to the President was also passed.

Meeting of Weekly Council, Wednesday, May 29th. Mr. THOMPSON, President, in the Chair.

A discussion was opened by the *President* on the Reports recently presented to the Society on

STEAM CULTIVATION.

The PRESIDENT said he had undertaken to open the discussion, not with the view of delivering a lecture upon steam cultivation, because he hoped their time would be much better spent than in listening to the opinions of any one man upon a topic so extensive, but for the purpose of making, in the first place, a few remarks upon the reports themselves, and then throwing out one or two propositions, or rather questions, for consideration by the meeting.

First, then, a few words about the reports themselves.

As one of those who took an active part on the committee appointed to organise an inquiry into the present state of steam cultivation on an extensive scale, I feel great pride and gratification in seeing laid before the Society, in the course of twelve months, such ample and excellent reports upon this important question. The duty undertaken by the Commisioners was very onerous, but they have carried it out in spite of many difficulties, and have displayed great talent in the way in which they have completed the task. That they should have persevered, notwithstanding a most unfavourable season, during which the weather caused delay in all the operations of husbandry during the summer and autumn, and prevented steam implements from being brought into use, as in any ordinary season, was only what was expected from men possessing the spirit of true Englishmen. That they should have collected such a mass of valuable materials was only the natural reward of their patience and perseverance. But when we come to look at the reports themselves, and see that, while they contain a great mass of details, involving continual comparison and repetition (without which indeed, the returns would have lost a large portion of their value), they at the same time come before us as a really readable volume, constituting consecutive narratives—I do say that it is a proof of literary merit of no common kind. Permit me, therefore, publicly, on behalf of the Society, to offer our best thanks to the Commissioners for the zeal with which they have undertaken a most difficult duty, for the perseverance with which they have carried it out in spite of numerous

difficulties, and for the great ability and talent with which they, especially those gentlemen to whom was entrusted the work of preparation, compiled reports that will no doubt be read with interest in all parts of the civilised world.

Having thus unmistakeably given my own opinion upon the character of these reports, I would briefly allude to some remarks I have occasionally heard, expressive of a little disappointment that they do not contain certain things which the objectors hoped and expected to find in them, but which I wish to show could not properly have been inserted.

I have heard it said that the reports should have contained A STATEMENT OF AVERAGE RESULTS, which would have settled some of the leading features and principles of steam-cultivation. This objection very probably takes some such form as this:—"It is now ten or twelve years since steam-cultivation was first introduced; there are hundreds of steam-engines at work on the land, and so extensive an inquiry as that of last year ought to have settled some of the main questions affecting steam cultivation, such as the average cost of steam *versus* horses, or any other power; the kind of implements which we had best employ; and the best mode of applying the best power." While not agreeing at all in these views, I think it right to mention them, because I believe that a complete answer can be given to any objections that may be raised.

I think we are very apt to attribute too much importance to a statement of average results. There is a feeling common amongst us, that if the number of instances of which the average has been taken is sufficiently great, we arrive at something like a law of nature from which there is no appeal. When considering the value of averages we ought especially to consider the kind of results from which the average is collected, because if the results themselves are dissimilar, it is plain that the average loses its value altogether. Take any familiar example—chairs, for instance. On comparing the cost of a certain number of chairs, of the same kind of material and manufacture, the average cost of a great number would furnish information as to their price; but on comparing chairs of all kinds, from the plain wooden kitchen chair to the highly-ornamented drawing-room chair, covered with satin-damask, the average struck would furnish no idea of the value to an intending purchaser. It would not be the average price of any particular kind of chair, and therefore, instead of being a guide, it would only lead him into error. If we apply this to the case in hand, we shall at once see that the cost of cultivating strong clay land will always be greater than the cost of cultivating light-land farms. Therefore the average cost of cultivating the two different kinds of land would be of no value to the man who wished to obtain information as to the cultivation of one or the other.

In endeavouring to strike an average of the results of steam cultivation in a certain number of cases where the soil is somewhat similar, you have to take into account the old adage, that "one man will thrive where another will starve;" and if you are to consider not only the differences of soil and climate, and the size and position of farms, but

also what is the average of the capacities of the men who would have to conduct the operations, then I think you will perceive that if our reporters had attempted to deal with the question of averages at all, they would have been brought into great difficulties in their calculations, and would in the end have produced a result of no practical value. Consequently, I think they have exercised a wise discretion in discarding all averages, and merely tabulating the results of their inquiries, side by side, for the convenience of the reader in search of special and comparative information.

Then we come to the second point I mentioned, *the kind of machinery to be adopted.*

There are strong reasons why the name of any individual maker should, if possible, not be brought forward in a report of this kind; and the only reason which would be sufficient to warrant the adoption of such a course would be the existence of so many makers, and so large a variety of apparatus, that it would be a positive benefit to an intending steam cultivator, bewildered in his choice, to be guided by the experience of gentlemen who, like our reporters, have had the opportunity of seeing many implements, and judging of their various capabilities. In the early days of steam cultivation there were a great number of inventors and makers. During the last five or six years, however, many of these implements have been found unable to stand the test of every-day wear and tear; the consequence is, that a few implement makers have gathered up the best of the inventions, and at the present time the number of those who stand as recognised manufacturers of steam cultivators is so small that if a purchaser cannot, after an exhibition of the implements at work, and a perusal of the descriptions furnished of their different merits and capabilities by those who have worked them, decide which maker he should go to, and which system he should adopt, he is, depend upon it, not in a position to begin to cultivate by steam, and had better postpone altogether the introduction of a steam implement upon his farm.

The third question I have heard raised is as to *the best mode of applying steam power, the system of husbandry which best brings out the full power of steam upon certain farms.*

It has been said that our reporters should have gone into those questions. Now, I do think that here, as in the other points, they have exercised a very sound discretion, and so far from feeling any disappointment myself that we have not made greater progress in settling a definite code of steam cultivation, I think we shall, if we look fairly at it, feel very grateful that so much has been accomplished. Of the answers returned in reply to questions sent out by the Society, 178 came from owners and employers of steam apparatus; and out of those 178, only one had had his apparatus at work for more than ten years; and only 33 have been working a steam apparatus more than *five* years. Some, perhaps, may say that a man who has been at work so long ought to have been able to make some progress towards establishing a definite system of cultivation adapted for steam; but it must be borne in mind that even so short a time as eight or ten years ago the

steam apparatus itself was by no means in the perfect state it is now. It required great and constant improvement; there were heavy expenses of wear and tear, and constant outlay for renewals. So I cannot see how those who have been at work five or six years only can be expected to have made much progress in fixing a definite code of steam cultivation. We must remember, too, that all this time they have had to prepare their farms for the introduction of steam, to instruct their men in the use of machinery, and to inform themselves, in many cases, as to the best mode both of working and applying the new power. In fact, it amounts to this, that they had not only to adapt agriculture to steam, but to adapt steam to agriculture at the same time. If that be so, we are undoubtedly much indebted to those pioneers of progress, who have thrown themselves heartily into this question, and have spared neither time nor money in their determination to make the cultivation of land by steam a great and signal success.

Having dealt with the objections which I have heard stated, and which I hold have no foundation, I would next ask your opinion and invite discussion upon certain questions which I will very briefly indicate.

One question I put before you is: What in your opinion is the most useful and practical feature of these reports? I have been asked that question myself; an answer can never be better supplied than by such a meeting as this, and I have thought it would not be a bad way of treating this discussion to repeat to you some of the questions put to me by gentlemen interested in steam cultivation.

As to the question, "Which is the most prominent practical feature of the reports?" I have no hesitation in saying, that I should assign the chief prominence to the fact that the reports are a faithful record of numerous cases where steam has been applied to the cultivation of farms under a great variety of circumstances, such as soil, climate, position, and other special conditions. These descriptions of so many different farms, and the faithful accounts of steam operations in a large number of instances, will furnish reliable data to almost every one who, finding himself in a difficulty, may wish to profit by the experience of others; he will be almost sure to find in these reports some case similar in many respects to his own. If the water he is obliged to use be bad, he will find instances in which a few pennyworths of Frank's fluid have been found sufficient to destroy its injurious character, and save the boiler. If in a wet season, that he should be in danger of losing his seed-time, he may read that others have got out of their difficulty by purchasing a steam plough in addition to a steam cultivator. Indeed, there is hardly any difficulty which can occur to a man using a steam apparatus which is not here described, and respecting which he will not find advice founded on experience to assist him out of it. Even in those few instances, where an inquirer fails to meet with the information he is in search of, the reports will tell him where he may apply for information to men who have probably gone through the same difficulties as himself.

Then, again, a man wishing to set up a steam apparatus would be able to find the experiences of those who, in somewhat similar conditions of soil and situation, have decided what kind of apparatus would be best suited for the particular system he meant to adopt—whether aiming at great results by a large outlay, or otherwise. There is, for example, the farm of Mr. Bomford, No. 69 in the report, which is rather an extraordinary instance of a man who is so taught by successful experience that he is not satisfied with having had two steam-engines and sets of working apparatus upon his farm, but intended, when the Commissioners visited him, to have two more. That I should consider a strong case of a man of large capital and energy going in for great results. If, on the other hand, a man wish to take the lowest mode, of employing a steam *auxiliary*, as it is very properly termed, and with a small outlay to get a powerful assistant (but still only an assistant) to the ordinary appliances of the farm, he has the experience of those who have gone before him in the same path, such experience being recorded and illustrated by most able pens, for his special guidance and instruction. These are my own opinions, but I should like to hear what, in the *opinion of the meeting*, are the most practical and useful features of the reports.

A second question, to which it might be useful to direct your attention, is,—"Does it appear from these reports that steam cultivation is successful as a commercial speculation?"

As the solution of a mechanical problem, no doubt it is a most perfect and thorough success. That which was proposed has been accomplished, and great feats of cultivation have been performed by steam which no other power could possibly have undertaken with the same result. But then comes the question, whether as a commercial speculation steam cultivation has generally been a success? Does it in the majority of cases lead to profit in a pecuniary point of view? I should be inclined to describe it as *a success which a very small amount of ignorance and inattention would convert into a failure*; a success where well managed, and a failure where badly managed. Between these two extremes there is to be met with almost every variety of great and modified success down to partial failure. A clever man will make steam cultivation answer; but a man who does not understand the subject himself, or cannot obtain an efficient manager or assistant, must be very careful how he touches the matter at all. That is the impression left upon my mind by a very careful comparison and perusal of the reports. No doubt upon clay land a depth and perfection of cultivation can be attained which could not otherwise be accomplished. In fact strong clay, such as that described in one of our reports two or three years ago,* as a soil varying at different seasons of the year from glue to cast iron, cannot be really and efficiently worked except by steam. But, unfortunately, that kind of soil is chiefly held in small occupations, and the problem how to apply steam succeesfully to them has not yet been solved.

* Vide 'Journal,' Vol. xxv., Part II., p. 521.

The purchase of a powerful steam apparatus by the owner of 200 acres or so of clay land, is, of course, out of the question, unless it be used on the adjoining farms as well. As yet, however, the partnership or company principle has not been sufficiently tried in agriculture for the results to be spoken of with any degree of confidence. This is one of the things upon which suggestions are desirable, and in which it would be most gratifying to see advancement made.

Again, with respect to light lands, I believe we shall soon see steam-engines very generally employed as an auxiliary on a large farm for cleaning stubbles in the autumn, for breaking up land for barley in the spring, and for many similar purposes. A light, cheap steam apparatus would be most valuable on such lands; indeed, I believe we shall soon see no farm of any considerable acreage without it. This is a matter, however, in which improvement is required; we want suggestions for the use and management of an apparatus for light lands, not too heavy nor requiring too much power, and purchaseable for a reasonable sum.

The three questions then which I should like to propound to the meeting are these—1st. Which is the most practical and useful feature of the reports? 2nd. Does it appear from these reports, or from the general knowledge of those who may speak upon the subject, that steam cultivation is successful generally as a commercial speculation? and, 3rd. In what direction does our present system of steam cultivation most require improvement?

Mr. Ruck said the reports must be read with general satisfaction by every member of the Society, for, no doubt, the investigations of the Commission had been carried out in a most impartial and straightforward way, both as regarded those who allowed their farms to be exhibited, and the implement-makers, whose machines were tried. The reports had suggested four questions to his own mind, rather different from those of the Chairman, but still equally important. They were, 1st. What power can we get out of sixpenny worth of coals? 2nd. Will work that is done by steam be equal or superior to that done by horse-power? 3rd. Will the land cultivated by steam be in a superior state to that cultivated by horse-power? 4th. Will the crops produced by steam cultivation be larger than those produced by horse-power? His own opinion was that sixpenny worth of coal would give as much power as one horse in a day's work; and that two operations with steam would be worth at least three by horse-power. By steam-cultivation, clay land would be brought into proper condition in the course of two or three years, and light land would be improved almost immediately. He had no hesitation in saying that steam-cultivation would cause an average increase of 8 bushels an acre in the crops throughout the country.

Mr. Smith (of Woolston) had read the reports very carefully, and would endorse the praise uttered by the Chairman respecting the authors. The reports, which would be found full of good and ample evidence if people would only take the trouble to read them, indirectly

touched upon the question as to how far steam-cultivation was a commercial success. Indeed, the whole thing resolved itself into the question, whether it would answer for a man to buy steam tackle. Upon that point Mr. Randell said that he bought a set in 1857, and had worked it ever since with the most successful and gratifying results; and the main advantage appeared to be the production of a deeper soil. What better evidence could be given of the commercial results of steam cultivation? Similar evidence was given by Mr. Stephenson of Yorkshire, who declared that he had not spent 5*s.* upon the repair of his implements, and who pointed out that the ropes and porters were the main item of wear. Mr. Armstrong and others supported this testimony as to the wearing powers of steam implements. In two cases it was shown that heavy lands had been worked at a trifle over 7*s.* per acre, while with horse work it would have cost at least 14*s.* The reports showed throughout that the drainage was greatly improved by the breaking-up of the under-soil. He (Mr. Smith) told the Society that years ago, having found it out on his own land, which was cold clay, as stiff as any in England, yet never a drop of rain ran off it; it all went through into the drains, leaving its fertilising properties in the soil as it passed through. If land could be cultivated 8 or 10 inches deep, and the steam-engine brought to bear upon it directly after harvest, what could the result be but a complete commercial success? The most extraordinary thing in connexion with steam cultivation was, that when land had been worked for some time, it required but a few days of engine work annually, so that farmers could afford to let their horses be idle for a portion of the year; indeed, since he had cultivated by steam, he had never used more than three horses, whereas before he used six at hard labour. Mr. Bomford showed that it saved him so much in horses that he was going to spend another 1400*l.* If, then, by steam cultivation the drainage was improved, the natural consequence in most soils must be an increase of produce. Professor Voelcker, in his Analysis of Soils, stated that there was a vast fertilising quality in our clays; and this he had experienced on his own farm, where he grew corn every year, wheat and beans going on regularly. As he could not manure the land deep enough for beans every year, he had occasionally to use a little artificial manure; and no doubt with this kind of cultivation he could keep growing on the cold clay for ever. The great point was to keep up the productive quality by artificial stimulants and deep cultivation. The most prominent feature of steam cultivation, in his opinion, was that it kept the land clean; whereas persons who had not the advantage of steam cultivation had dead fallows every four or five years, and had to use three or four operation for their fourth crop. Another prominent feature in the report was the proof it gave that a steam-engine did three or four times more work in one operation than that done by a horse; a double depth was reached, and a double effect produced. Again, Mr. Prout said he had saved considerably by using Fowler's apparstus. Upon the question of produce, Mr. Randell, who was an excellent farmer, said he did not

appear to make any increase, but he acknowledged that he got stronger straw; and Mr. Stephenson, in Yorkshire, said he got good crops before he used steam cultivators, aud he got no better now. The fact was, that where a man farmed high, it was difficult to drive cultivation beyond a certain point; but when it was acknowledged that the straw was stronger, it was evident there must be in the end a better result with less manure. Referring to the Chairman's remarks as to an apparatus suitable for light soil, he thought we should not look to reduced prices in machinery. He would not reduce the cost of his, for the machine he worked was as good now as it was ten years ago. The Commissioners said that Howard's windlass was better than his, but that was a matter of opinion. His was constructed upon sound mechanical principles, and had stood the test of ten years' work. He did not, however, wish to enhance the value of his own apparatus. It was of no consequence to him whether he sold one or not. He made them, not to sell, but to work upon his own farm. He would call special attention to No. 8 in the Report, showing how an outlay of say 360*l.* on steam-cultivation enabled Mr. Cranfield to add 225 acres to his farm without buying a horse; otherways he would have required 40 horses in all.

Professor VOELCKER, referring to a visit he had recently paid to Mr. Prout's farm, bore testimony to the improvement which had been effected in the drainage by steam cultivation; this, however, was nothing new to him, as he had many years ago seen similar results on Mr. Ruck's farm. This recent visit to Mr. Prout's, continued the Professor, makes me say, I believe that if steam-ploughs were placed on our strong clays, we should ultimately not want any drainage at all. The water that falls now goes through the drains, simply because it runs through the cracks in the ground; it does not go through the soil. If, however, the good effects of steam cultivation could be realised, we should have an abundant store of food within the reach of the growing crop; like Mr. Smith of Woolston, we should only require once now and then a little artificial manure to stimulate the surface, and we could then depend upon the intrinsic virtue of our clay-soils. This may, at the present time, be thought a little Utopian; but I believe that when steam cultivation has reached a high state of perfection, we shall effect a great saving in our manures. We shall not then require any looking after our drains, nor shall we have to take them up, and put fresh pipes in, or furnish extra drains to carry off the water; for, by the constant cultivation of the heavy clay-lands, we should improve their mechanical condition to such an extent that every inch of rain-fall would be taken up and utilised.

Mr. THURLOE could not agree with the preceding speaker, that cultivation by steam would entirely do away with the necessity for drainage. In the concluding report of the Committee of Investigation, it was stated that engines required to be driven at a uniform speed, and pretty fast, by which, he presumed, was meant that the steam apparatus for breaking up the land ought to go at a uniformly quick pace. In that view he quite concurred, but he feared that with Howard's apparatus the thing

could not be done in all cases or in all weathers. That apparatus was worked by a leather strap (A Voice: "It can be worked in many ways"). At any rate that was one of the ways, and the strap could not always be kept on in wet and windy weather, although in fine weather no doubt the apparatus answered extremely well. He mentioned that defect some time ago to Mr. Howard, who then brought out a union-joint, which was fixed to the central axle of the fly-wheel, and, of course, being so fixed, it retarded the pace. If anything could be devised by Mr. Howard to make the apparatus work in all weathers, they would have an almost perfect implement.

Mr. Bomford explained with reference to his purchase of a double set, that he had 600 acres of land where he lived, and 300 nine miles away; it was for the 300 acres that the second set was purchased, and when not required for his own purposes he intended to let it out. If the 900 acres were all together, one set of tackle would be sufficient. As soon as his crop was off he was anxious to get his land broken up. The work could only be done in fine weather, and therefore the sooner the better.

Mr. Bulstrode, who had read with great pleasure the full and able report of the Commissioners, said that the question of outlay would always be one of primary importance to the ordinary farmers of England. The trials made hitherto were in favour of the direct system, in which the apparatus was the most scientific, but also the most expensive; and if farmers were to take the verdict of that Society from the trials already made, they would have to purchase at a cost from 800*l.* to 1500*l.*, which a great many neither would nor could do. The reports, which quite coincided with his own experience, revealed several startling results. In the first place, the trials of machinery did not appear to have been always successful. Two machines, purchased by Lord Berners and Lord Vernon, respectively, though they took prizes at the Shows where they were exhibited, yet both proved failures in practice. Again, although the stationary or roundabout system had been condemned by that Society, yet hundreds of sets on that system had been working successfully for years, and had yielded a good profit to those using them, Mr. Smith, of Woolston, being among the number. The results, though at first rather startling, ceased to be so, if they considered how the trials had been made. There were small regular plots of ground, the machines were of the best description, and the men by whom they were managed were skilled men, well up to their work. All this involved great advantage over the work on an ordinary farm, and, in some degree, explained why a system of great general utility did not appear to advantage when compared with one of greater cost and special excellence. The case was something like that of a short run between a thoroughbred racer and a hunter. This was a matter which he thought should be specially brought before the farmers of this country; for if they found many instances in which farmers having engines from 8 to 10 horse-power were enabled, by making an additional outlay of from 250*l.* to 300*l.*, to adopt steam-cultivation successfully, surely it was a matter well

worthy of attention. Had farmers simply followed the verdict of the Society, they must have spent from 800*l.* to 1500*l.*, or have let steam-cultivation alone. At the same time, while speaking so positively in favour of the stationary system, he hoped he should not be misunderstood. He was perfectly convinced, and the remarks of the Commissioners bore him out in stating, that the direct system was the most scientific and economical for farms of large size, and with fields favourably situated; but on farms of ordinary size, with fields of ordinary shape, with ordinary covenants and leases, and with ordinary purses the indirect system was generally the best, and would produce the greatest result with the least risk.

To those who asked, "Why not hire machinery on the more economical and scientific system?" the remarks of the Commissioners on the hiring system afforded a full and sufficient answer. The two great advantages of steam-cultivation, namely, a reduction of the number of horses required, and facilities for performing operations at a rapid pace, were both to a great extent lost under the hiring system. Farmers could not venture to reduce their horse-strength, if uncertain whether they could have an engine to cultivate their fields when they wanted it; if, a few days after ploughing, they thought it would be advantageous to give the land a good stirring with the drag-harrow, which was a very valuable adjunct to steam-cultivation, they could not do it if the machinery was gone. In the latter case, they would have to fall back on their horses, letting them travel over the ground, thus undoing much of the very work which had just been done so carefully and at such great expense. Again, under the hiring system, in some cases they would have to pay almost double what the rate of cost would be if they had tackle at home. Others might differ from him on that point, but such was the result in his own case. Then, again, such was the importance of judicious management, that, without it, the best tackle made might be perfectly useless, while with it even inferior tackle might be comparatively useful. Sometimes persons did a great deal of mischief to their tackle by doing at once what ought to be done in two or three consecutive operations.

Again, it was most important to avoid all unnecessary hindrances. When he first began cultivating by steam, he had so many stoppages that he soon began to study how he could reduce them to a minimum, and he found it most important for the tackle to be worked in the best manner. An advantage of the indirect system, which had hardly been sufficiently spoken of, was the saving in the expense of water-carriage, for whereas under the direct system on many farms the water-carriage must involve great expense and vexation, under the indirect system it could be done almost for a nominal sum. His object, he wished it to be understood, was not to condemn the more scientific apparatus, which was well adapted for large and special farms, but to show the great value of the cheap and stationary apparatus. He felt perfectly convinced that steam-cultivation would overcome all the obstacles it had to contend with. It had needed, however, some impetus, and he was sure the thanks of the country were due to the Royal Agricultural

Society of England for the money which had been devoted to the late investigation, and for the ability displayed in the valuable reports which had been published.

Mr. DAVIS totally dissented from the opinion that steam-cultivation would produce any effect on strong land, unless thoroughly drained in the first instance. Whilst complimenting the Commissioners on the ability with which they had done their work, he pointed out instances of divergence in their statements which he did not see how to reconcile. For instance, in one report it was stated that the tackle could be removed in an hour and a half, by four horses; in another, that the work of removal would require six horses for a day and a half! He believed it was quite impossible for any man, however active, to remove tackle from his farm in less than half a day.

Mr. EDMONDS said he had had a steam-plough for three or four years, and liked it extremely; in fact he should not like now to farm without one, especially on strong land. He could not agree with Dr. Voelcker, that with steam-cultivation they could do away with drainage altogether; for in practice they found that with a depth of 10 or 12 feet of clay, the rainfall would either remain on the land till it was evaporated, or must run away from the surface through the drains, and he did not think it could remain long enough to evaporate without injuring the crops. His opinion was that they must continue to drain deeply in clay-soil, and one advantage of the steam-plough was that it would help to do away with deep furrows. On light land he thought steam-cultivation was much less expensive than cultivation with horses; but the implements at present employed might be improved, and special attention should be directed to those required for the after-working of the soil. Land laid up in autumn, and left in that state in winter, might in his opinion be prepared for a crop with a simple scarifying. In his neighbourhood coals cost about 1*l.* per ton, and it would be well if something could be done to economise fuel. The difficulty of getting Fowler's plough on to strong land in wet weather might be obviated by having roads on headlands, or by having a patten, like Boydell's, on the wheels of the engine. Under ordinary circumstances it took about two hours to remove a set of Fowler's tackle with a pair of extra horses.

Lord VERNON, who farms nearly 2000 acres of very heavy clay-land, which he at first regarded as a hopeless task, said:—I watched very carefully the series of trials, which commenced at Leeds, down to that which took place at the last Show of the Society at Newcastle. I had the honour to act, during almost the whole time, as one of the Stewards of Implements connected with steam-ploughing; but it was long before I could satisfy my mind that any implement had sufficient power to work my land. It is perfectly true, as stated by Mr. Bulstrode, that the prize set of apparatus on the direct system, which I bought at Newcastle, did not work so successfully on my farm as on the trial; but I am perfectly satisfied that, so far as the trial went, the judges, who devoted an immense amount of attention to the task, came to a correct decision, and chose the best implement exhibited; and I can

only account for its not proving so successful on my own farm by the fact that the land was unusually stiff and ungrateful, and that the breakages were, in consequence, very heavy. I am very glad to have this opportunity of stating that Mr. Fowler, of whom I bought that implement, supplied me with other apparatus on terms very creditable to him indeed; and that set, which has been on my farm for a year, has worked very successfully in every way. I might appeal to Mr. Wilson to confirm my statement that, instead of land which was before almost unproductive, I have now land which will produce some of the best wheat-crops in the county, It is, I think, hardly fair to lay the blame of any failure on the Society, for the successful adoption of steam-cultivation has been very gradual. I have no doubt that, as we go on, we shall improve in details. It is my opinion—I know it differs from that of many of my colleagues on the Council—that trials of steam-cultivators, which are enormously expensive, ought not to be so frequent as they are now; and that, as we have now a codification of the results of steam-cultivation throughout England, when trials hereafter recur, thrice as much attention should be paid to them as has been paid hitherto. My experience as a Steward of Steam-cultivation has been that the duties of the judges have been almost more than men could perform within the time allotted to them, and certainly more than consistent with securing a satisfactory report of results. I cannot quite agree with Mr. Smith, of Woolston, that when the ploughing-apparatus is not at work there is no cost attending it. The case has been very different with me. I have worked my apparatus with an expensive staff; the manager has been paid very high wages; and I am firmly convinced that unless duly qualified men, superior to ordinary agricultural labourers, are employed, the cost of breakages will be enormous. If the wages paid are higher than those of ordinary agricultural labourers, the excess should be fairly set down to the apparatus. I may add that I pay my staff on the scale recommended to me by Mr. Fowler, and I find from the reports of the Commissioners that it is not higher than what is generally paid elsewhere. I did not think, when Dr. Voelcker got up, that he would so completely dash certain of my hopes to the ground. I live, as I have intimated, in a district where the land is very stiff, and where 3000 acres have been drained at a cost of 6*l.* 10*s.* per acre; so that his remarks on drainage have rather damped my feelings. His Lordship concluded by remarking how very highly the Society ought to value the labours of the Commissioners.

Dr. Voelcker, in explanation, said it was an accepted axiom that without drainage no improvement of land was possible, and he had not intended to express any opinion to the contrary. His remarks applied to the future; his impression being that, many years hence, after plenty of good steam-cultivation, the mechanical condition of the land would be so improved that the want of drainage would be far less than at present. Of course they must begin with drainage, and what he hoped for might not be realised in some cases under 10, 20, or even 50 years. He had been speaking prophetically.

The PRESIDENT said he had hoped that Professor Voelcker, for whose scientific attainments he felt the greatest possible respect, was going to withdraw altogether what he must characterise as rank heresy.

Mr. SMITH (of Woolston) observed that he had worked his tackle with his ordinary farm-labourers from the time he started, eleven years ago, and had found no difficulty whatever. He had experienced no breakages, and his implement was as good now as ever it was. In consequence of his windlass being made on an unsound principle, he changed it at the end of about four years, and adopted the 4-wheeled windlass, which had kept in very good order. The cost was comparatively trifling, being simply the interest of money on about 180*l.* to himself, but 210*l.* to other people.

Mr. HOLLAND, M.P., having remarked upon the advantage likely to arise from the publication of the Report in the Society's Journal, said:—There is this feature in connexion with all professions, that you should have a knowledge of the individual with reference to whom, as a professional man, you are about to act. The first act of a medical man, when treating a patient, is to feel his pulse; and so, in like manner, we should feel the pulse of our own land, so to speak, before we apply steam-power to it in any shape. In this Report any man who wishes to apply steam-power to his land, whatever that land may be, will find all the information he needs in a condensed and handy shape. Now, in spite of what Dr. Voelcker says, I believe that you must have deep drainage in connexion with steam-ploughing. Take my own county for example. The heavy land in the Vale of Gloucester is all in deep ridge and furrow, the work of some unkind agriculturists in former ages, and this must all be undone by the steam-cultivator before we shall make a full profit out of that land. It is thrown up in such immense high ridges, that a 5 ft. 6 in. man, in one furrow, can hardly be seen from the next adjoining furrow. And not only is the land on the surface of that shape; but, on going down into the subsoil, you find that the under-surface has taken the same shape, and that that is a heavy clay. How, then, are you to deal with land such as that, without drainage? Again, these furrows very seldom run parallel with one another, and are generally in the form of an S. I tried to drain them in parallel lines, but my drainage failed, and I was obliged to follow the old course of ridge-furrows, as the only mode of getting the water off the land. Through the applications of steam-ploughing, however, I am gradually bringing down these high ridges. I find that we need not be at the expense of putting drains in the furrows so deep as would be otherwise necessary; and now, after seven years' steam-ploughing, I have more or less done away with the ridges, and made the surface comparatively flat. I too, like Mr. Smith, find that the water does not run off the land, so as to do it damage by carrying away the fine soil into the furrows; but now that the water runs off through the drains, it takes a much less quantity with it; and I admit that the drainage is of less consequence now than it was formerly, because there is a larger flow of water through the interstices of the land into the drains, and the land is placed in such a position that it can take advantage of the rainfalls.

I should be sorry, however, under any circumstances, to begin the expensive system of steam-ploughing without the previous application of drainage to the land.

Turning to another aspect of the question, I consider steam-cultivation as not only a revolution in our method of working the heavy clay-lands of this country, but also a moral revolution, affecting every class of persons connected with agriculture. I look upon it as impossible for tenants in the long run to take up steam-ploughing, unless the farms are put into proper condition for them. Small fields and hedgerows must be done away with, for experience tells me that the economy of steam-ploughing depends on the quantity of rope employed, and the absence of impediments caused by hedgerows. But an important question now arises, "Will the tenant-farmer, when the advantages of steam-ploughing are well understood throughout the country, embark his capital in the enterprise where his tenancy is for a short period only?" I believe that we shall find these holdings cease to be yearly, and that a system of leasing will pervade the whole country. Here I connect the landlord and the tenant together in the matter of steam-ploughing; let me now connect the labourer with it, and show what will be the moral advantage to him. Of course you take your best labourers; like Mr. Smith, I have men from my own village who have been educated as steam-ploughers. The term during which I have been engaged in the system has given time enough for a generation of young steam-labourers to grow up; and I find that those have become a species of aristocracy among the villagers, that they value the advantages of their position, and are determined to hold it, and have their children educated also, so that they in their turn may become some of the best men in the village. All these things are going on together; and, as I have remarked elsewhere, your best labourers, your steam-ploughers, or those whom you employ in connexion with steam-cultivation, must come out of decent cottages.

Mr. Stephenson spoke in favour of the round-about system, after ten-years' experience of it. He concurred in thinking that all land ought to be drained before it was steam-ploughed.

Mr. Watts, who had been working Fowler's apparatus for the past six years, said that last season he added another engine to the set. Like Mr. Holland, he had had to encounter the difficulty of some very high-backed land, which, however, he had gradually reduced, and in every way he was satisfied with the system. The labourers in the field had been taught to work the apparatus successfully.

Mr. Coleman (Chelmsford), whilst concurring in what had been said with respect to the value of the reports published in the Society's Journal, drew attention to the fact that in the statistical report the cost of working the apparatus constructed by himself was shown in a different manner to that generally adopted throughout the report. The case he referred to was in No. 23, where the cost of working was represented as 17*s*. 4*d*. per acre, whereas he believed that taking a day's work at 1*l*. 11*s*. 4*d*. for seven acres per day, it was under 5*s*. an acre. But by some curious arrangement, which he did not under-

stand, a charge of 3*l.* 11*s.* 3*d.* was added, thus producing a result of 17*s.* 4*d.* per acre. He fancied it must have arisen thus:—The year 1865, when only 150 acres were done, was an unfortunate year for steam-ploughing, and he presumed that the whole amount of the interest on capital, maintenance, and so forth, was concentrated in those few days.

Mr. Jacob Wilson, who had been appealed to by Lord Vernon, in the course of his address, said that when his Lordship commenced steam cultivation, although he had a very small farm in hand, he had to engage a special staff to work a pair of engines. In fact, he was simply working for the good of his tenantry; and when the men were not employed in steam operations, they were occupied in the plantations and in other work. No practiced farmer would take that as a fair example of employing agricultural labour; but he could now get labourers in Northumberland who could work the engine efficiently; in fact, any of his boys were quite competent to the task. He had adopted Fowler's double-set engine after much attention to the subject of steam cultivation, and opportunities of investigating the trials of the Royal Agricultural Society, which many other men had not possessed. Up to the year 1864, he had never seen a set of tackle which to his mind was what he wanted. He might, perhaps, be peculiarly situated in having three roads running through his farm; consequently, however, much he enlarged his fields, he always had crooked fences. Owing to the difficulty in working about circuitous hedges with a single engine, he obtained a Fowler's direct set; with this he was perfectly satisfied, for he could work it at any angle in any corner, and from whatever place he chose to put the engine. In his country the best coal was from 3*s.* to 4*s.* a ton, which brought expenses down considerably, in comparison with those of Mr. Ruck. It was a matter of deep gratification to him to have been associated in the preparation of the report, and that it had been so well seconded by the country at large, and especially by gentlemen who used machinery in the cultivation of the land, of whatever make it might be. The desire of the Council was, that the report should have no bias in favour of, or against any individual maker; and he was sure that the reporters would have the credit given them of having made a fair statement. That report would, he thought, bring out one point in a practical way which had never before been educed. A great many persons, whom he might term amateurs, seemed to think of going into steam cultivation, with the hope that it would do *everything* for them; but those who had had experience of its working, he was sure, would agree with him that there could be no greater mistake. Even in the matter of manure, for instance, his experience was that he did not want less, but probably more, because steam enabled him to grow a greater variety of crops. That, he thought, settled the point. The President had told them that only a very few farmers had had this means of cultivating the land for more than five years, in fact, he (Mr. Wilson) believed that, as a rule, it could not be for more than three or four years. Now, during that period they would naturally have, as he himself had experienced, a good deal of up-hill work.

They probably went a little deeper than necessary. Perhaps they broke the pan, and probably some part of their implements also. It was not, therefore, until their second course through the farm that they realised the great advantage derivable from the system. Mr. Randell was one of the few men who had been long at it; and certainly, to raise, as he had done, the value of a farm consisting of a strong blue tough clay from 8*s.* an acre to its present value, said a great deal for the utility of steam cultivation. Most fervently did he hope that the best wishes of the Council for the furtherance of English agriculture, and especially for steam cultivation, would be amply realised through this Report.

Mr. BEALE BROWNE said he was the occupier of about 2000 acres of land, and had been in possession of one of Fowler's sets of tackle for six years. This he had kept in constant use, and he had arrived at the conclusion that it was a fine weather implement only, and that in such circumstances it was most valuable; but it ought not to be used at any other time. He did not think that the cost of working, had anything to do with the question; in comparison with horse-labour, the chief advantage of it was, that it could be used and made to do an enormous amount of work at the right time. After repudiating the notion that in consequence of the adoption of steam cultivation, they would be able to do without manures, he said one of the faults he found with the system was, that he sometimes went deeper than he wished to go; but on the whole he could speak most highly of it, and his only wonder was that it was not more widely adopted.

Mr. MORTON suggested that as the reports were of so valuable a character it was desirable that they should be circulated in a cheaper form than in the Society's Journal.

The PRESIDENT stated that it was intended to publish them in a 5*s.* volume directly; and that if it were found necessary the Council would no doubt be prepared to publish an extract at a still lower price, eighteen pence or a shilling. As Mr. Browne had described his implement as a fine-weather one, he wished to know whether that remark applied to Fowler's only or to any other steam apparatus?

Mr. BROWNE replied that he could not speak much of any other than Fowler's, because he had never had any other, and no other was used in his neighbourhood, Swindon in Wiltshire. In wet weather it was found that the tackle broke; and, in fact, he was of opinion that the time for bringing it out was when the sun shone on both sides of the hedge, and they could do a good long day's work. It had been observed that the ordinary agricultural labourer was not qualified for the work, but he had installed his men into the office, and, following the instructions given by Mr. Fowler, had had no difficulty whatever in working the apparatus with them; of course their wages had to be raised.

Mr. JAMES WEBB said that within a radius of seven miles of Evesham, there were not less than nine sets of tackle at work, so he was obliged to follow the stream. Those who used it five or six years ago were using it now, those who had come into the neighbourhood since had adopted it, and there was not one instance of its proving

unsuccessful or being given up. He mentioned this because in the vicinity of Worcester, which was not many miles off, two or three landlords had started implements which were always under repair. Success, he believed, greatly depended on the skill ef the people by whom the machines were worked. Those in the neighbourhood of Evesham, with the exception of Mr. Holland's and one other, were in the hands of the farmers, and worked by their labourers. At first he hesitated whether he should adopt the direct-action, or the round-about system. His farm consisting partly of light land and partly of strong clay, altogether 600 acres in extent, was large enough to have employed the direct-action; and he could get on it at all times; but he adopted the cheaper plan, and was perfectly satisfied with the results. The original cost of the steam-engine and tackle, including thrashing apparatus, was 700*l.*

Sir W. Stirling wished to know whether any one present, with a small holding, say of 300, 400, or 500 acres, had purchased a steam-engine himself, and could state the benefit derived from its use. At that moment they were all, as it were, in conflict with the labourers, who were constantly being withdrawn from the land for many and various purposes. Therefore it was, that agriculturists turned to machinery with an anxious eye. He farmed many hundred acres of light land, but had not yet been induced by anything he had heard to lay out a large sum of money in the purchase of a steam-plough; nor did he find that his neighbours were inclined to do so either. He considered that a discussion like the present would be much more valuable to the farmer than any report that might, be published on the subject, however admirably got up.

The President said that Mr. Stephenson, for one, who had given his testimony, was one of the early patrons of steam-machinery, and spoke well of it after eleven years' experience on a farm of about 390 acres. Mr. Robert Helmsley also farmed a small holding by steam.

Mr. Webb observed that one of his neighbours purchased an engine last autumn for a farm of less than 400 acres, and had employed it very successfully.

Mr. Helmsley said that before introducing the steam-engine on his farm, he looked round to see to what purposes he could apply it besides cultivation, and he had turned it to account in grinding, thrashing, and carrying on a variety of other operations. In his opinion a man ought to have at least 300 acres of arable land if he would use the steam-engine; he certainly should not have procured one himself had he not held pretty nearly to that extent. The system he adopted was the round-about, which he considered the simplest and best.

The President then moved, and the Earl of Powys seconded a vote of thanks to the Committee of Inspection, and especially to the gentlemen who had acted as reporters. The motion having been carried by acclamation—

Mr. Algernon Clarke, one of the reporters, briefly acknowledged the compliment. Speaking for himself and his colleagues, he said they were not prepared to assume the responsibility of recommending

Members' Veterinary Privileges.

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No. 2. The remuneration of the Inspector will be 2*l.* 2*s.* each day as a professional fee, and 1*l.* 1*s.* each day for personal expenses; and he will also be allowed to charge the cost of travelling to and from the locality where his services may have been required. The fees will be paid by the Society, but the travelling expenses will be a charge against the applicant. This charge may, however, be reduced or remitted altogether at the discretion of the Council, on such step being recommended to them by the Veterinary Committee.

No. 3. The Inspector, on his return from visiting the diseased stock, will report to the Committee, in writing, the results of his observations and proceedings, which Report will be laid before the Council.

No. 4. When contingencies arise to prevent a personal discharge of the duties confided to the Inspector, he may, subject to the approval of the Committee, name some competent professional person to act in his stead, who shall receive the same rates of remuneration.

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Royal Agricultural Society of England.

1867-8.

President.

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Food, Prices, Import of Grain.

Sales of R
Prices of C
Pauperism.

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